DOCUMENT RESUME

ED 040 039 SE 008 062

AUTHOR	Alden, John D.
TITLE	Demand for Engineers and Technicians - 1968.
INSTITUTION	Engineering Joint Council, New York, N.Y. Engineering Manpower Commission; National Industrial Conference Board, Inc., New York, N.Y.
PUB DATE	Dec 69
NOTE	43p.
AVAILABLE FROM	Engineering Manpower Commission, Engineers Joint Council, 345 East 47th St., New York, N. Y. 10017 ($5.00)
EDRS PRICE	EDRS Price MF-$0.25 HC-$2.25
DESCRIPTORS	*Employment Patterns, *Engineering Technicians, *Engineers, Job Market, Job Placement, Labor Demands, *Manpower Needs, *Occupational Surveys, Personnel Needs
IDENTIFIERS	Engineering Manpower Commission

ABSTRACT

Contained are the results of a survey designed to determine the demand for engineers and technicians in industry, education and government in June-July, 1968. Questionnaire returns from 926 organizations employing a total of 270,617 engineers and technicians constituted the basis for the analysis. Some of the major findings are that (1) large organizations employed most of the technical manpower - 62% were working for companies with 5,000 or more employees, (2) 44% of technical personnel were working in 24 major metropolitan areas, (3) in terms of industry group, manufacturing provided 60.3% of the sample followed by government (19.2%), non-manufacturing industry (16.0%) and education (4.4%), and (4) more than 60% of the responding employers establish recruiting goals on a regular basis, most often during one particular month each year. Also contained is a discussion of employment by curriculum, employment by function and growth of engineering employment. Numerous statistical tables, charts, and bar graphs are included. Copies of the questionnaires used in the survey are also included. (LC)

EDO 400039

DEMAND

FOR ENGINEERS AND TECHNICIANS — 1968

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

a survey conducted by the

ENGINEERING MANPOWER COMMISSION
OF ENGINEERS JOINT COUNCIL

IN COOPERATION WITH

THE NATIONAL INDUSTRIAL CONFERENCE BOARD

SE 008 062

ENGINEERS JOINT COUNCIL

ENGINEERS JOINT COUNCIL (founded in 1941 and incorporated in 1958) is an organization of engineering societies whose general objective is to advance the art and science of engineering in the public interest.

In furtherance of this general objective the Council shall:

(a) Provide for regular and orderly communications among its member societies.
(b) Act as an advisory and coordinating agency for member society activities, as mutually agreed.
(c) Organize and conduct forums for the consideration of problems of expressed concern to member societies.
(d) Identify needs and opportunities for service in the engineering community and inform the concerned engineering institutions.
(e) Recommend appropriate programs of studies and research to engineering institutions and especially to member societies.
(f) Undertake, in accordance with policies mutually agreed to, specific activities or projects that the member societies acting individually could not accomplish as well.
(g) Represent the member societies when they deem such joint representation desirable.

THE ENGINEERING MANPOWER COMMISSION OF ENGINEERS JOINT COUNCIL

The Engineering Manpower Commission was organized in 1951 as part of Engineers Joint Council, to serve as a focus for national technological manpower problems.

The Commission's program is carried out through the collection, analysis, and publication of significant data on engineering manpower, as well as the development of programs and policies designed to acquaint the public with the importance of engineering to the national welfare.

The Engineering Manpower Commission is charged with the following responsibility:

"To engage in studies and analyses of the supply, demand, and utilization of engineering and technical manpower; to make recommendations, conduct programs, and develop reports concerning these aspects of engineering and technical manpower; and to carry on such other programs in the field of manpower as may be authorized by the Board of Directors of EJC."

EMC OFFICERS AND STAFF

DONALD E. IRWIN ..... Chairman
WILLIAM HAZELL ..... Vice-Chairman
RICHARD C. FREMON ... Chairman, Surveys Committee
JOHN D. ALDEN ..... Executive Secretary

ED0 40039

Demand for Engineers and Technicians 1968

ENGINEERING MANPOWER COMMISSION
of Engineers Joint Council

345 East 47th Street
New York, N. Y. 10017

DECEMBER 1969

PRICE: $5.00

Acknowledgments

This study was conducted under the direction of John D. Alden, assisted by Carol Iceland of the EMC staff, who were responsible for carrying out the survey, screening and categorizing the returned schedules, and preparing the report. The undersigned was responsible for interpretation and evaluation of the data.

Coding and data processing were performed by Shmuel Schraier and Nancy Gaston under the supervision of Daniel Creamer, all of the National Industrial Conference Board.

Among the many others who contributed helpful advice and suggestions during the course of this study, special thanks are due to Donald E. Irwin, Theodore J. Carron, Richard C. Fremon, and William M. Hoyt, all of the Engineering Manpower Commission.

John D. Alden
Executive Secretary
Engineering Manpower Commission

Contents

CONTENTS PAGE

Introduction 5
General Findings 7
Engineers – Employment and Demand 9
Technicians – Employment and Demand 20
Appendix 31
Facsimile of Questionnaire 33

CHARTS

1. Regional Distribution of Employment 7
2. Major Areas of Employment for Engineers and Technicians Covered by This Survey. 8
3. Establishment of Hiring Goals 8
4. Distribution of Engineers by Curriculum and Industry 9
5. Distribution of Engineers by Function and Industry 11
6. Non-Graduates as a Percentage of All Engineers, by Industry 12
7. Distribution of New Engineer Hires by Education or Experience Level 13
8. Engineer Separations by Industry and Reason 14
9. Shortfall in Engineer Hiring Goals for 1967-1968 by Education or Experience Level 16
10. Actual Shortage or Excess in Engineer Hires, 1967-1968 17
11. Degree of Shortage or Excess in Engineer Hires as a Percentage of Planned Goal 18
12. Distribution of Technicians by Curriculum and Industry 21
13. Distribution of Technicians by Function and Industry 22
14. Distribution of New Technician Hires by Education or Experience Level 23
15. Technician Separations by Industry and Reason 25
16. Shortfall in Technician Hiring Goals for 1967-1968 by Education or Experience Level 26
17. Actual Shortage or Excess in Technician Hires, 1967-1968 28
18. Degree of Shortage or Excess in Technician Hires as a Percentage of Planned Goal 29

TABLES

1. Distribution of Respondents by Industry 8
2. Percent Distribution of Engineers by Curriculum and Industry 10
3. Percent Distribution of Engineers by Work Function and Industry 10
4. Growth of Engineering Employment 12
5. Number and Per Cent of New Engineer Hires, July 1967 – July 1968, by Level of Formal Education 13
6. Engineering Separations by Reason 15
7. Comparison of Hiring Objectives for Engineers and Number Hired 1967-1968 16
8. Planned Hires and Current Employment of Engineers by Curriculum 18
9. Planned Hires and Current Employment of Engineers by Functional Areas 19
10. Employer's Subjective Evaluation of Difficulty in Hiring Engineers 1968 Compared with 1967 19

TABLES **PAGE**

11. Ratio of Technicians to Engineers by Industry, 1967 and 1968 20
12. Curriculum Distribution of Technicians by Industry 20
13. Functional Distribution of Technicians by Industry 22
14. Change in Technician Employment by Industry, 1967 to 1968 23
15. New Hires of Technicians by Type of Training and Industry July 1967 – July 1968 24
16. Separations of Technicians – Rate and Percent Distribution by Reason and by Industry 1967-1968 26
17. Comparison of Hiring Objectives for Technicians and Number Hired 1967-1968 27
18. Planned Hires of Technicians by Curriculum, 1968-1969 27
19. Planned Hires of Technicians by Functional Area 1968-1969 28
20. Employer's Subjective Evaluation of Difficulty in Hiring Technicians 1968 Compared with 1967 30

APPENDIX TABLES

1. Engineers and Technicians in Respondent Companies Classified by Company Size as Measured by Total Employees 31
2. Engineers and Technicians in Respondent Companies Classified by Company Size as Measured by Employment of Engineers and Technicians 31
3. Estimated Number of Engineers to be Hired for Various Curricula 31
4. 1968 Engineer Recruitment Compared to 1967 32
5. 1968 Technician Recruitment Compared to 1967 32

Introduction

Why a Demand Survey?

Continuing assessment of the nation's engineering and technological manpower resources is one of the basic objectives of the Engineering Manpower Commission. Since the Commission's organization in 1950, the growth of the nation's economy, the rapid advances of science and technology, and changing requirements for national defense have reflected themselves in the demand for manpower. Indeed, it is becoming more and more apparent that skilled manpower is probably the limiting resource in today's technological world. The utilization of this scarce resource in the face of competing demands is a major challenge to which no easy solution exists.

Since 1951, the Engineering Manpower Commission has been conducting surveys of the demand for engineers. Other agencies, notably the U.S. Department of Labor and the National Science Foundation, have also made large-scale projections of supply and demand. As might be expected, each survey has produced different estimates of how much manpower will be needed and in which areas of technology the need will be greatest. One feature has stood out in all of these surveys, however, namely that the demand appears to be greatly in excess of the projected supply of formally educated engineers, scientists, and technicians. In the arguments back and forth over methodology, many have lost sight of the fact that the differences are ones of degree but not of direction. The important thing is that the projected supply of college graduates will be insufficient to meet any of the demand figures projected in recent years.

Demand is a particularly difficult quantity to measure. What constitutes demand? Few would agree on a definition. To some, it means job vacancies, but even here it is difficult to decide when a vacancy really exists. Many companies have large numbers of "vacancies" which they do not really expect to fill in the immediate future. There are others who say that demand is the difference between the number currently employed and the number companies would like to have. Still others would equate demand with those requirements needed to fulfill firm plans for the future – new mines coming into production or new plants under construction. One well-known "demand index" is based solely on recruiting activity as measured in the advertising columns of newspapers and magazines.

In approaching the subject of demand it is helpful to adopt the economist's approach – supply and demand must be equal by definition. One may wish or expect what he likes for any time in the future, but at any actual time supply and demand are going to be equal. The way in which they equalize is by adjustments on both sides of the equation. The supply can be increased by attracting people from other fields by offering them higher salaries and benefits, by retraining and upgrading employees, by working overtime and delaying retirement, and by other similar means. Demand can be reduced by redefining jobs so that they require less skill, by shifting priorities of projects, by automation, etc. Rosy hopes of future expansion fade under the realities of the present, and employers "make do" with what they have.

Viewed in this light, future "demand" is something which can and must be constantly changing. One of the biggest unknowns is always what to expect of the nation's overall economy. Estimates of employment in the future are obviously tempered by considerations which cannot be predicted reliably and are beyond the control of the individual or company making the prediction.

Because of these difficulties, there are many who sincerely believe it is futile to attempt predictions of future demand. Frequently they feel that great harm is done because of exaggerated interpretation of demand fluctuations and "scare" stories in the press. Such things undoubtedly cause much unnecessary alarm and may even deter a few young people from entering careers which they might otherwise have chosen. The Engineering Manpower Commission, however, recognizing the difficulties involved in measuring demand and the dangers of possibly unfavorable reactions to its findings, firmly believes that estimates of the demand for engineers are essential planning tools for the future. We cannot ignore the problem simply because we know our solutions will not be perfect.

Our method of assessing demand is based on the assumption that personnel executives in industry, government, and education are in the best position to understand and evaluate present and future factors affecting their own organizations. By classifying and summarizing data reflecting the judgments of many such individuals, we believe we can provide useful information regarding the nature and level of current and future employment of engineers and technicians.

Definitions

ENGINEERS Engineers for purposes of this survey include engineering graduates employed in all activities, including supervision and management, and those lacking formal engineering degrees, but whose experience and training permit them to hold positions normally requiring such a degree.

TECHNICIANS Technicians, as defined for this survey, perform some, but not all of the functions normally done by engineers and applied scientists. They may work independently or as assistants to engineers or scientists. Their job requires the application of scientific principles to the performance of their work. They have technical education of two or more years full time beyond high school, or equivalent industrial training and experience. Technical institute education usually embraces a two-year post high school program leading to an associate degree or certificate, and includes technical programs in community colleges or other insititutions. Also included are four-year programs leading to a bachelor's degree in engineering technology or industrial technology, but not an engineering degree.

GROWTH As used in this report, growth refers to the increase in the employment of, or the demand for, engineers and technicians, whether expressed in absolute quantities or as percentages.

SEPARATIONS This term refers to the total number of engineers or technicians leaving the employ of the reporting company because of death, retirement, resignation, discharge, or similar reason during the period under study.

Organization of the Survey

The Engineering Manpower Commission has conducted surveys of demand at varying intervals since 1951, most recently (previous to this study) in 1966.[1] The National Industrial Conference Board has also been interested in the area of manpower demand and has conducted extensive studies on the use of job vacancies as a measure of demand.

During 1967 the two organizations decided to make a joint effort toward better understanding of the demand for engineers and technicians in the U.S. A completely new questionnaire was prepared and mailed to a list of several thousand employers who have participated in earlier EMC surveys as well as to those associated with NICB. The initial mailing was made in late June 1968, with a follow-up in August. Data in the returned schedules were up to date as of July 1, 1968.

All returns were screened for accuracy and usability, coded according to industry group, size of company and geographical location, and delivered to NICB for key punching and computer processing. Of the many data tables run off, only the most important have been incorporated in this report. Others were experimental efforts aimed primarily at developing improvements in future surveys.

Interpretation of Results

Because this survey represented a significant departure from earlier EMC studies, we have deliberately avoided direct comparison of 1968 results with past reports. It is our intention to conduct a series of surveys using the same basic approach, the next of which is scheduled for January 1970. By that time we believe we will be on sufficiently firm ground to attempt to interpret trends and changes in the demand situation.

For this report, interpretation has been largely confined to the results of the 1968 survey alone, with most evaluations based on the comparison of replies to different questions. In a few instances judgmental evaluations have been made on the basis of general familiarity with the engineering and technical manpower situation through EMC studies and standard published reports.

---

[1] Demand for Engineers and Technicians – 1966, New York: Engineers Joint Council, November 1966, $4.00

General Findings

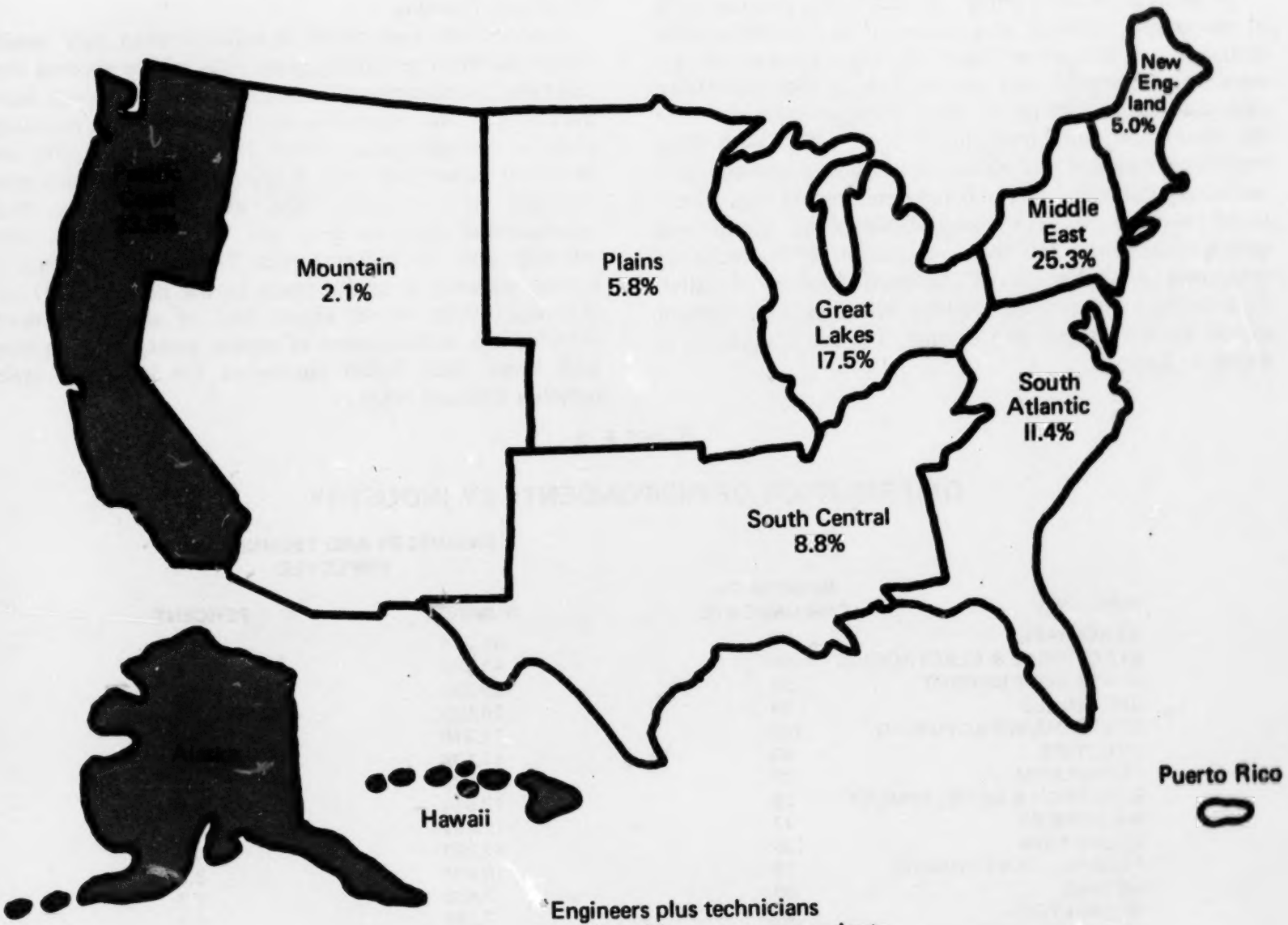
Survey Coverage and Distribution

Replies from 926 organizations employing a total of 270,617 engineers and technicians constituted the basis for this analysis. Large organizations employed most of the technical manpower reported in this survey – 62% were working for companies with 5,000 or more employees. Coincidentally this same percentage applied for organizations employing more than 1,000 engineers. Seven companies, each with more than 50,000 employees, reported almost one fourth of the total engineers and technicians covered by this survey. The complete distribution by company size is shown in Appendix Tables 1 and 2, page 31.

Not quite half – 44% – of the engineers and technicians covered by this survey were working in the 24 major metropolitan areas. The New York City area, with 7.6% of the total, had the most, followed by Philadelphia, with 4.6%, Detroit, with 4.3%, Los Angeles with 3.8%, and the Chicago area with 2.4%. The regional distribution is shown in Chart 1.

CHART 1

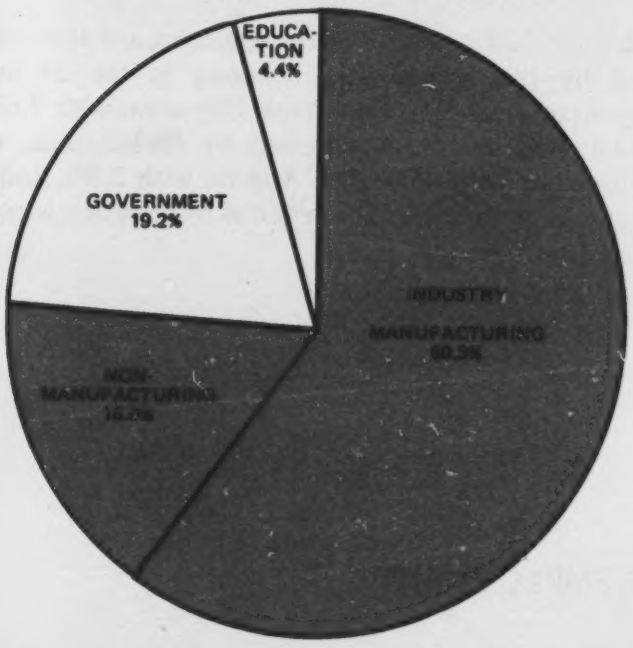
REGIONAL DISTRIBUTION OF EMPLOYMENT*



*Engineers plus technicians employed by survey respondents as of July 1968.

CHART 2

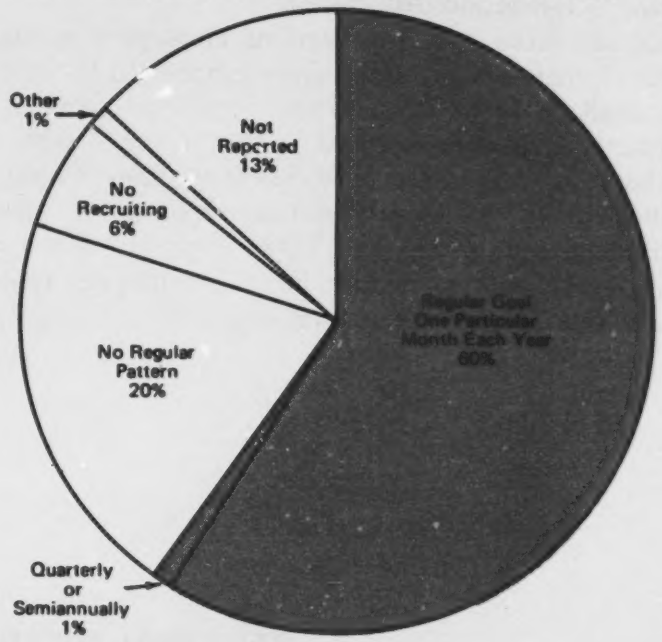
MAJOR AREAS OF EMPLOYMENT FOR ENGINEERS AND TECHNICIANS COVERED BY THIS SURVEY



In terms of industry group, manufacturing provided 60% of the sample followed by government, non-manufacturing industry, and education (Chart 2). The largest employers were the aerospace and electrical-electronics industries, each with about 17% of the total. State governments were the next most well represented, with 14%. Other large employers included the chemical, utilities, petroleum, and machinery industries, research and development, and educational institutions. The smallest identified group was transportation with less than one percent of the technical manpower total. Because of the small numbers of individuals in the transportation industry, statistics for this group should be interpreted with caution. The full breakdown is shown in Table 1.

CHART 3

ESTABLISHMENT OF HIRING GOALS



Based on replies from 926 employers

Manpower Planning

Respondents were asked to indicate when they usually firmed up their recruiting goals. The replies showed that this type of manpower planning was quite prevalent. More than 60% of the responding employers establish recruiting goals on a regular basis (Chart 3), most often during one particular month each year. Regularity of setting such goals increases with company size, except that very small organizations seem to treat the function a little more seriously than medium-size ones. The lowest incidence of regular planning is in the group having between 100 and 500 employees, where about half of the respondents reported the establishment of regular goals; for companies with more than 5,000 employees the incidence varies between 85% and 100%.

TABLE 1

DISTRIBUTION OF RESPONDENTS BY INDUSTRY

INDUSTRY	NUMBER OF RESPONDENTS	ENGINEERS AND TECHNICIANS EMPLOYED	
		NUMBER	PERCENT
AEROSPACE	23	45,241	16.7
ELECTRICAL & ELECTRONICS	86	45,102	16.7
STATE GOVERNMENT	26	36,858	13.6
CHEMICALS	39	20,879	7.7
OTHER MANUFACTURING	123	17,316	6.4
UTILITIES	83	17,138	6.3
PETROLEUM	27	14,563	5.4
RESEARCH & DEVELOPMENT	25	13,654	5.0
MACHINERY	77	12,821	4.7
EDUCATION	135	11,983	4.4
FEDERAL GOVERNMENT	15	10,004	3.7
METALS	88	7,436	2.7
CONSULTING	68	7,284	2.7
LOCAL GOVERNMENT	42	5,049	1.9
CONSTRUCTION	53	4,323	1.6
TRANSPORTATION	16	966	0.4
ALL RESPONDENTS	926	270,617	100%

Engineers - Employment and Demand

Employment by Curriculum

The largest curriculum group reported by survey respondents was electrical engineering, closely followed by mechanical engineering. Each of these curricula accounted for about a quarter of the total. The remaining half consisted of civil, chemical, aerospace, industrial, and smaller groups. The concentration of engineers of any given curriculum varies widely from industry to industry (Chart 4), but in many areas of employment there is less predominance by a single curriculum than might be expected. Table 2 (see page 10) gives the breakdown of major curricula within each industry group.

Of the major engineering disciplines, civil engineers make up the overwhelming majority in state governments and well over half in the consulting area. Civil engineers are also the largest single group in local governments, transportation, and construction.

Electrical engineers dominate in research and development, utilities, and the electrical-electronics industry, and are the largest discipline in the federal government, aerospace, and education.

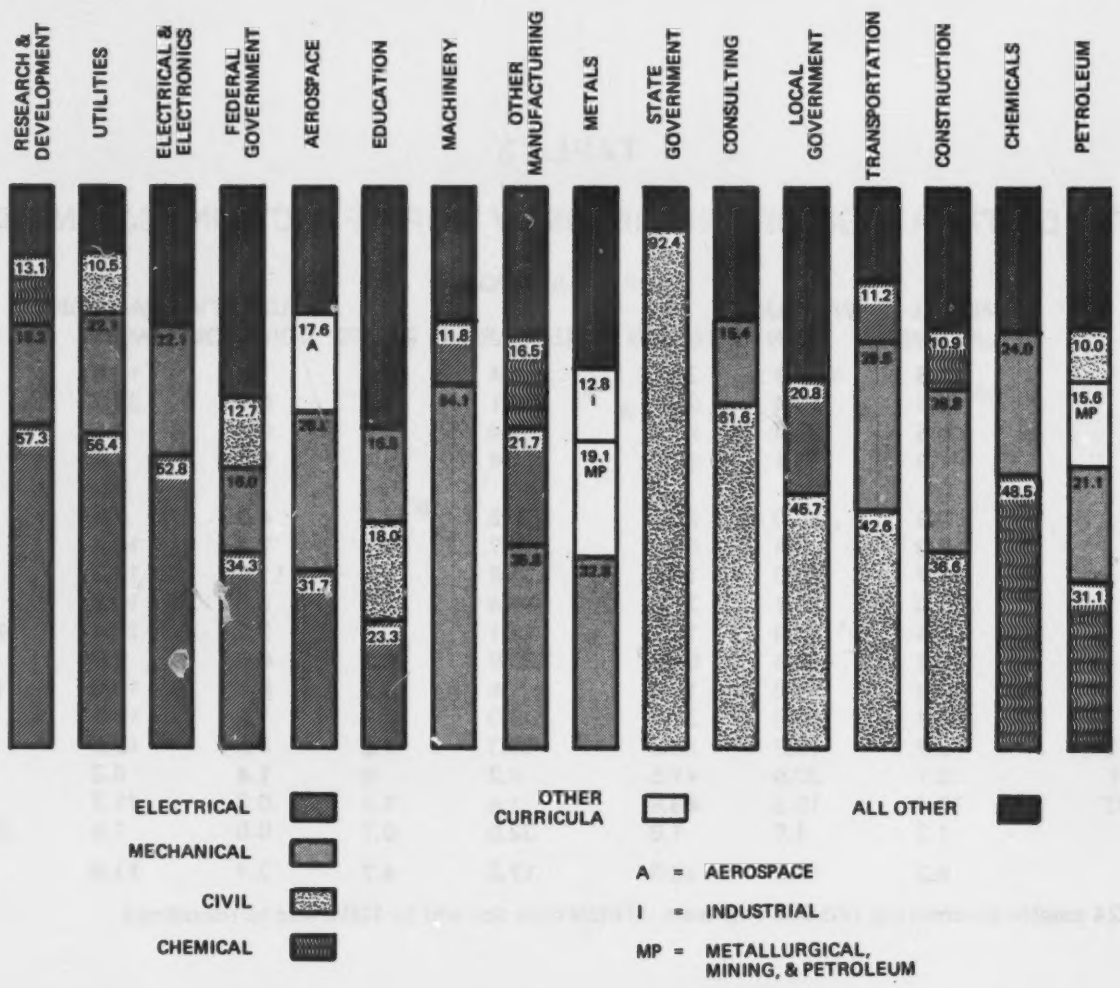
Mechanical engineers provide more than half of the engineering force in the machinery industry and are the most numerous group in "other" manufacturing and metals.

Chemical engineers hold the lead in the chemicals and petroleum industries. Of the other disciplines, aerospace engineers naturally are strong in the aerospace industry, metallurgical and petroleum engineers in the metals and petroleum industries, and naval architects and marine engineers (grouped under "other engineering") in the federal government. Industrial engineers are widely distributed in practically all areas of employment. Civil, electrical, mechanical, and chemical engineers also are well represented in a variety of fields besides the ones that they dominate.

Because not all types of employers are equally well represented in this survey, the returns do not provide a reliable measure of the percentage distribution by type of employer within the nine engineering curriculum categories. For example, state governments were proportionately over-represented compared to most industry groups; therefore the proportion of civil engineers who were employed in state governments would be overstated compared with their representation in other sectors of employment.

CHART 4

DISTRIBUTION OF ENGINEERS BY CURRICULUM AND INDUSTRY



NOTE: ONLY THOSE ACCOUNTING FOR AT LEAST 10% OF THE TOTAL IN EACH INDUSTRY ARE INDICATED.

TABLE 2

PERCENT DISTRIBUTION OF ENGINEERS BY CURRICULUM AND INDUSTRY

	CURRICULUM									
INDUSTRY	AERO-SPACE ENG.	CHEM-ICAL ENG.	CIVIL ENG.	ELEC-TRICAL ENG.	INDUS-TRIAL ENG.	MECH-ANICAL ENG.	METALLURG. MINING PETROLEUM	OTHER ENG.	NO SPECIFIC REQUIRE.	ALL ENG. CURRIC.
AEROSPACE	17.6	2.5	7.1	31.7	1.6	28.5	1.5	0.8	8.5	100
CHEMICALS	0.1	48.5	5.8	8.0	6.6	24.0	2.1	4.9	*	100
CONSTRUCTION	*	10.9	36.6	9.5	3.2	28.8	2.2	2.9	5.8	100
CONSULTING	*	6.8	61.6	8.4	1.7	15.4	0.7	3.7	1.6	100
ELECTRICAL & ELECTRONICS	0.5	2.0	1.7	52.8	8.4	22.1	1.0	4.2	7.3	100
MACHINERY	0.9	3.3	3.0	11.8	6.2	64.1	3.0	5.4	2.3	100
METALS	2.4	6.4	9.7	9.7	12.8	32.8	19.1	6.5	0.4	100
OTHER MFG.	6.4	16.5	5.7	21.7	8.9	35.8	1.6	3.0	0.5	100
PETROLEUM	0.2	31.1	10.0	9.2	3.3	21.1	15.6	8.3	1.1	100
R & D	0.6	13.1	1.6	57.3	1.2	18.2	3.2	4.6	0.2	100
TRANSPORTATION	5.9	1.4	42.6	11.2	2.6	29.5	2.1	1.4	3.3	100
UTILITIES	*	2.2	10.5	56.4	2.7	22.1	2.3	2.8	1.1	100
FEDERAL GOVERNMENT	3.4	4.2	12.7	34.3	3.1	16.0	5.6	16.4	4.2	100
STATE GOVERNMENT	*	0.2	92.4	1.8	0.3	1.5	1.0	0.6	2.2	100
LOCAL GOVERNMENT	*	0.7	45.7	20.8	0.7	8.0	0.2	0.8	23.2	100
EDUCATION	6.7	7.8	18.0	23.3	5.8	16.5	5.2	9.3	7.5	100
ALL RESPONDENTS	5.1	11.3	16.5	25.9	4.3	24.7	3.5	4.3	4.5	100

Based on replies from 882 employers covering 154,952 engineers.
*Less than 0.1%.
(Totals may not add to 100% due to rounding.)

TABLE 3

PERCENT DISTRIBUTION OF ENGINEERS BY WORK FUNCTION AND INDUSTRY

	WORK FUNCTION								
INDUSTRY	INSTAL-LATION	PRODUC-TION	DESIGN	RESEARCH	SALES	QUALITY CONTROL	MANAGE-MENT	OTHER	ALL FUNCTIONS
AEROSPACE	11.6	3.9	34.8	26.4	1.1	1.8	15.8	4.6	100%
CHEMICALS	5.5	19.4	21.7	19.1	7.2	0.9	22.2	4.1	100
CONSTRUCTION	0.6	29.4	62.3	1.4	1.6	0.3	2.6	1.7	100
CONSULTING	1.9	13.1	65.0	4.4	1.4	0.7	7.6	5.8	100
ELECTRICAL & ELECTRONICS	3.9	24.0	36.2	9.6	13.4	4.3	4.9	3.5	100
MACHINERY	2.0	9.4	50.0	10.7	10.7	2.2	10.4	4.3	100
METALS	16.7	22.0	14.1	11.8	9.4	11.9	12.3	1.8	100
OTHER MFG.	5.6	13.1	37.8	19.6	3.5	6.8	10.8	2.7	100
PETROLEUM	7.4	19.4	12.3	12.1	7.1	3.1	16.4	22.3	100
R & D	0.4	0.5	56.9	30.9	0.8	0.6	2.8	7.1	100
TRANSPORTATION	33.2	13.8	15.9	1.6	0.5	5.7	13.0	16.4	100
UTILITIES	7.4	23.8	31.8	3.0	8.4	1.2	18.9	5.6	100
FEDERAL GOVERNMENT	2.7	10.2	26.8	38.3	1.2	3.8	10.5	6.5	100
STATE GOVERNMENT	3.7	33.5	41.5	4.2	0	1.4	6.3	9.3	100
LOCAL GOVERNMENT	17.4	18.3	48.8	1.4	1.2	0.2	11.7	1.0	100
EDUCATION	1.3	1.5	1.8	32.5	0.7	0.8	1.9	59.6	100
ALL RESPONDENTS	6.2	15.0	33.3	17.2	4.7	2.4	11.6	9.5	100

Based on replies from 824 employers covering 146,008 engineers. (Totals may not add to 100% due to rounding.)

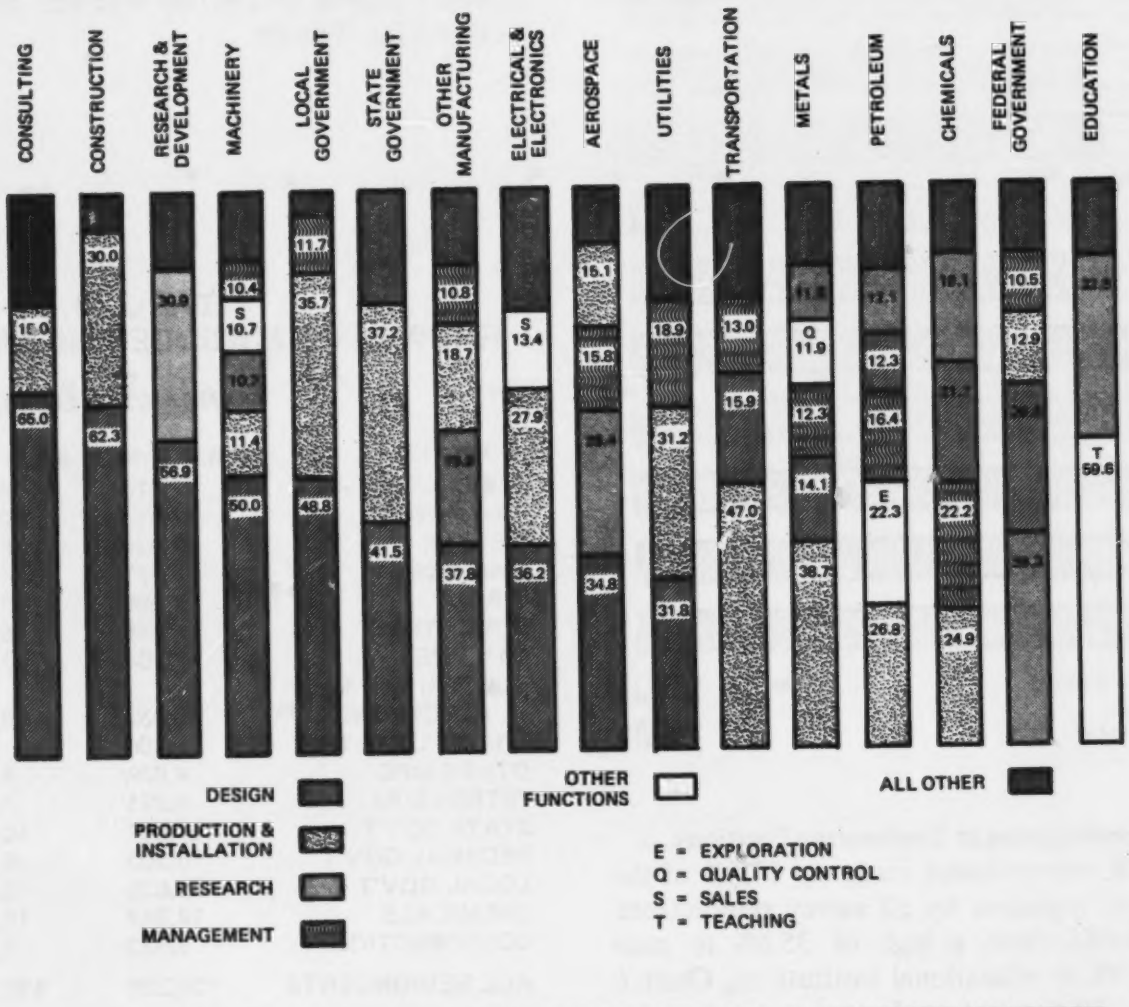
Employment by Function

When employed engineers were broken down by major work activity or function, a third of the group were engaged in design. Research, production, and management were other functions occupying the attention of large numbers of engineers. Again, significant variations occurred in different industry groups.

Chart 5 and Table 3 give the functional breakdown on an industry by industry basis. It is interesting to observe that design is the predominant engineering function in all but six groups, even in R & D companies. Research is the largest function in the federal government, management in the chemicals industry, and installation in the transportation companies. Special patterns existed in educational institutions, where the "other" category undoubtedly consisted principally of teaching, and in the petroleum industry, where large numbers engaged in exploration and extraction were reported under "other" functions. The small percentages of engineers in quality control and sales are worth noting, as well as the variation in these functions from industry to industry.

CHART 5

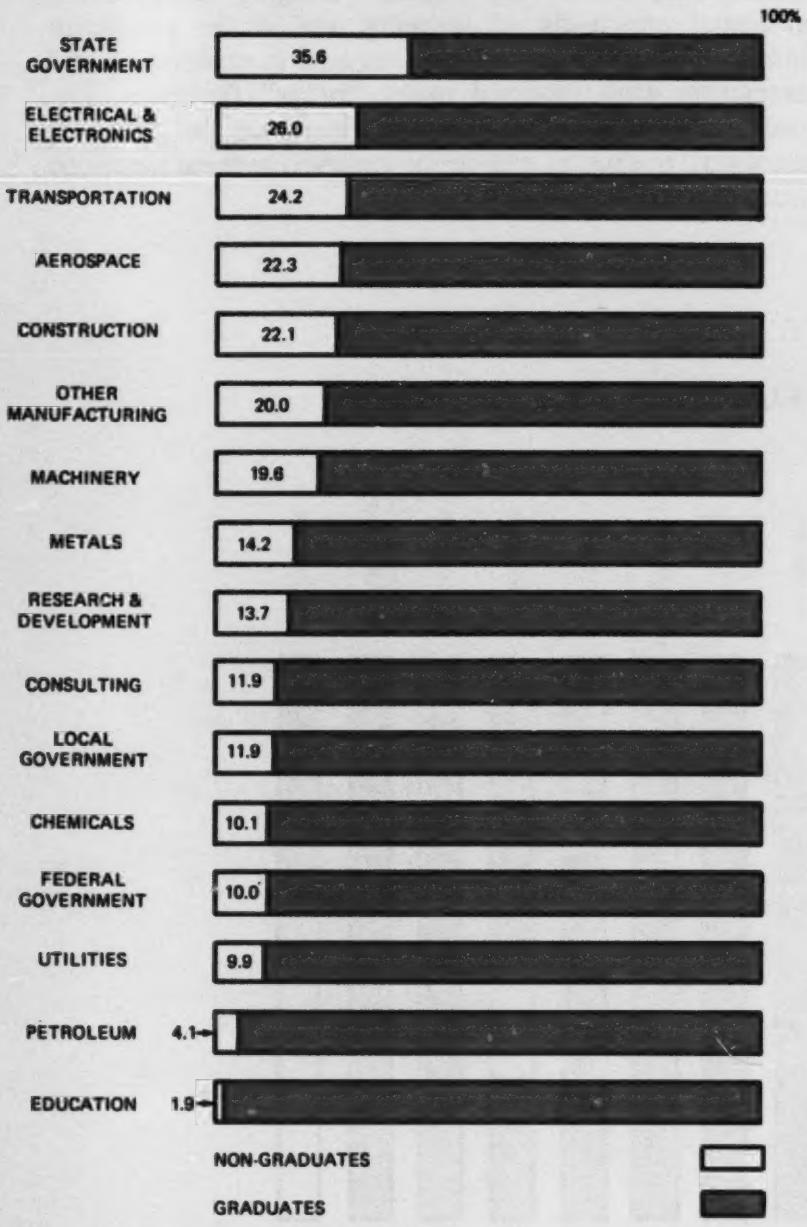
DISTRIBUTION OF ENGINEERS BY FUNCTION AND INDUSTRY



NOTE: ONLY THOSE FUNCTIONS ACCOUNTING FOR AT LEAST 10% OF THE TOTAL IN EACH INDUSTRY ARE INDICATED.

CHART 6

NON-GRADUATES AS A PERCENTAGE OF ALL ENGINEERS, BY INDUSTRY



Employment of Nongraduates in Engineering Positions

As of July 1968, nongraduates made up 17.8% of the people employed as engineers by all survey respondents. The percentage varied from a high of 35.6% in state governments to 1.9% in educational institutions. Chart 6 shows the results for all types of employers.

Growth of Engineering Employment

For the respondents as a group, engineering employment increased by 5.1% between July 1, 1967 and July 1, 1968. However, it is more meaningful to look at the picture industry by industry as in Table 4. Here the greatest growth is seen to have occurred in the consulting, aerospace, metals, machinery, and R & D industries. Construction declined slightly, while chemicals and the government areas were low. Growth in total engineering employment is not the only factor affecting the situation, however. The number of engineers employed in each industry, the specialties required, and the availability of new graduates to fill specialized needs are all equally important. Also the normal losses due to death and retirement vary from industry to industry. Employment opportunities for engineers can be good even in industries that are not growing strongly. Then too the situation can change rapidly from year to year, the aerospace industry being a case in point. Its rapid growth in 1967-68 was not matched by similar prospects for 1968-69.

TABLE 4
GROWTH OF ENGINEERING EMPLOYMENT

	ENGINEERS EMPLOYED		
INDUSTRY	JULY 1, 1967	JULY 1, 1968	PERCENT CHANGE
CONSULTING	3,713	4,092	10.2
AEROSPACE	27,512	30,206	9.8
METALS	7,834	8,419	7.5
MACHINERY	4,571	4,859	6.2
R & D	7,000	7,368	5.3
EDUCATION	6,235	6,515	4.5
UTILITIES	7,104	7,372	3.8
ELECTRICAL & ELECTRONICS	18,752	19,428	3.6
TRANSPORTATION	450	466	3.6
OTHER MFG.	4,626	4,792	3.6
PETROLEUM	4,271	4,398	3.0
STATE GOV'T	10,651	10,937	2.7
FEDERAL GOV'T	5,203	5,336	2.6
LOCAL GOV'T	2,036	2,083	2.3
CHEMICALS	14,847	15,045	1.3
CONSTRUCTION	1,423	1,409	-1.0
ALL RESPONDENTS	126,228	132,725	5.1

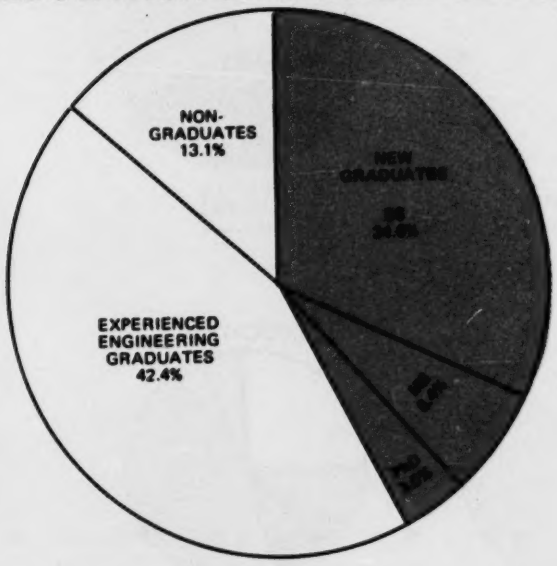
Based on replies from 576 employers.

New Hires

Respondents gave detailed information accounting for 22,914 new hires broken down percentagewise as shown in Chart 7.

CHART 7

DISTRIBUTION OF NEW ENGINEER HIRES BY EDUCATION OR EXPERIENCE LEVEL



It should be noted that only about 45% of the new hires represented new entrants to the engineering work force. The rest were mainly experienced people who shifted from one employer to another, as it is unlikely that many non-graduates were hired to fill engineering positions without significant prior experience.

Hiring patterns varied considerably among types of employers. Most of the doctor's degree graduates were employed either in education or in research activities. Experienced engineers constituted more than half of the new hires in aerospace, construction, consulting, and electrical-electronics companies, whereas new graduates were more in demand in most other areas of employment. Non-graduates had the greatest likelihood of being hired by state government, aerospace, transportation, and electrical-electronics employers. The demand for new bachelor's degree graduates was highest in the petroleum, utilities, "other" manufacturing, chemicals, metals, and machinery industries and in government. Master's degree graduates were most likely to be hired in education, research, petroleum, and chemicals. The detailed breakdown is given in Table 5.

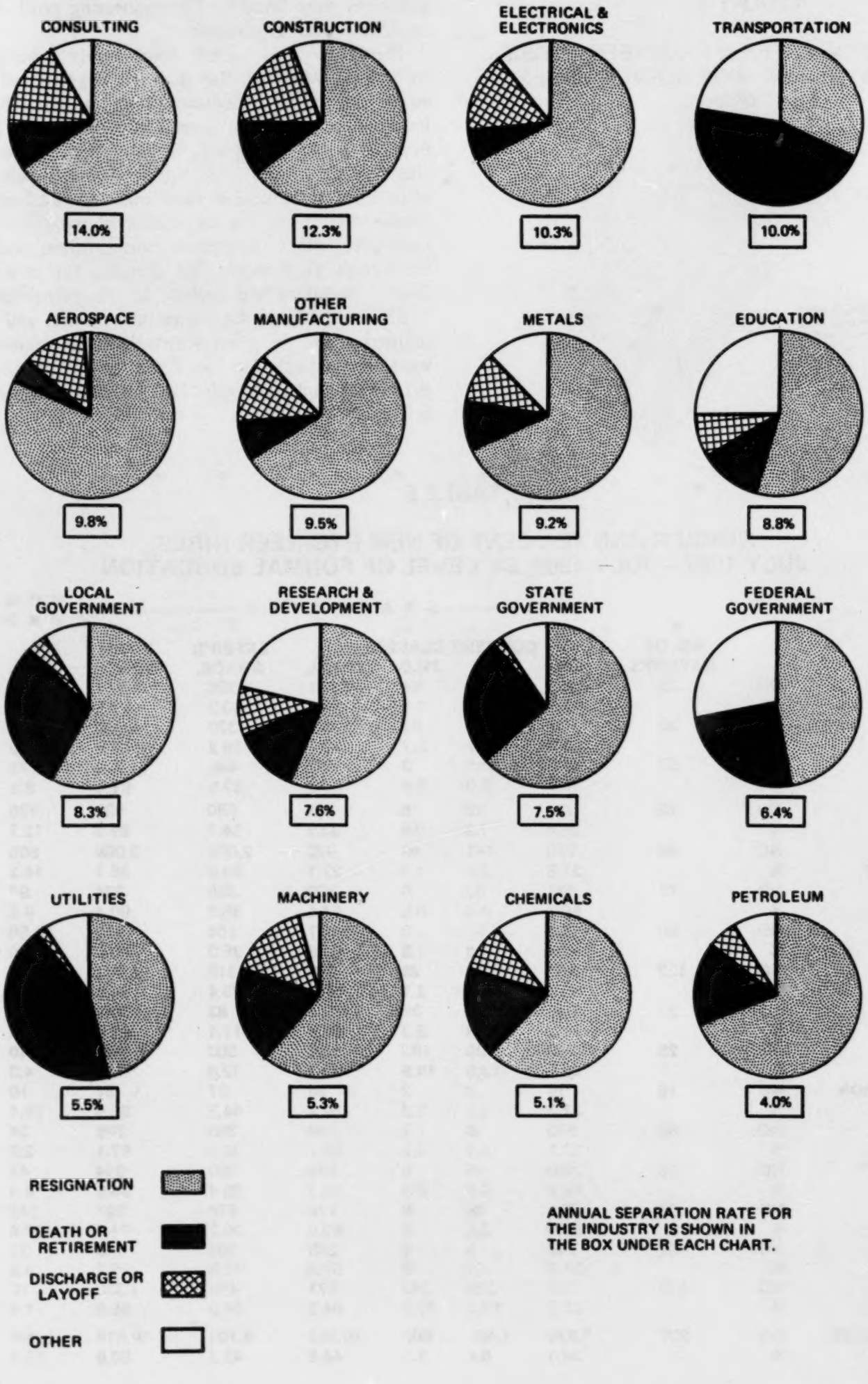
TABLE 5

NUMBER AND PER CENT OF NEW ENGINEER HIRES, JULY 1967 – JULY 1968, BY LEVEL OF FORMAL EDUCATION

			GRADUATES						NON-GRADS.	
			CURRENT CLASSES				EXPER'D	TOTAL		
INDUSTRY		NO. OF RETURNS	B.S.	M.S.	PH.D.	TOTAL	GRADS.	GRADS.		TOTAL
AEROSPACE	NO.	23	1,236	231	64	1,531	3,386	4,917	1,457	6,374
	%		19.4	3.6	1.0	24.0	53.2	77.2	22.8	100
CHEMICALS	NO.	39	777	171	81	1,029	370	1,399	14	1,413
	%		55.0	12.1	5.7	72.8	26.2	99.0	1.0	100
CONSTRUCTION	NO.	53	275	51	3	329	445	774	73	847
	%		32.5	6.0	0.4	38.8	52.5	91.4	8.6	100
CONSULTING	NO.	68	273	78	6	357	580	937	136	1,073
	%		25.4	7.3	0.6	33.2	54.1	87.3	12.7	100
ELECTRICAL & ELECTRONICS	NO.	86	780	141	49	970	2,099	3,069	509	3,578
	%		21.8	3.9	1.4	27.1	58.6	85.7	14.2	100
MACHINERY	NO.	77	491	33	5	529	355	884	94	978
	%		50.2	3.4	0.5	54.1	36.3	90.4	9.6	100
METALS	NO.	88	296	52	9	357	164	521	58	579
	%		51.1	9.0	1.5	61.6	28.3	90.0	10.0	100
OTHER MFG.	NO.	123	767	93	29	889	318	1,207	152	1,359
	%		56.5	6.9	2.1	65.5	23.4	88.9	11.2	100
PETROLEUM	NO.	27	540	96	25	661	83	744	3	747
	%		72.2	12.8	3.3	88.4	11.1	99.6	0.4	100
R & D	NO.	25	283	130	183	596	300	896	40	936
	%		30.2	13.9	19.5	63.7	32.0	95.7	4.3	100
TRANSPORTATION	NO.	16	19	3	2	24	27	51	10	61
	%		31.2	4.9	3.3	39.4	44.2	83.6	16.4	100
UTILITIES	NO.	83	510	36	2	548	250	798	24	822
	%		62.1	4.4	0.2	66.7	30.4	97.1	2.9	100
FEDERAL GOV'T	NO.	15	480	65	9	554	390	944	43	987
	%		48.7	6.6	0.9	66.3	39.4	95.6	4.4	100
STATE GOV'T	NO.	26	671	48	0	719	278	997	343	1,340
	%		50.0	3.6	0	53.6	20.7	74.4	25.6	100
LOCAL GOV'T	NO.	42	243	5	0	248	200	448	23	471
	%		51.6	1.1	0	52.6	42.5	95.1	4.9	100
EDUCATION	NO.	135	295	234	342	871	459	1,330	19	1,349
	%		21.9	17.3	25.3	64.5	34.0	98.6	1.4	100
ALL RESPONDENTS	NO.	926	7,936	1,467	809	10,212	9,704	19,916	2,998	22,914
	%		34.6	6.4	3.5	44.5	42.3	86.8	13.1	100

CHART 8

ENGINEER SEPARATIONS BY INDUSTRY AND REASON



ANNUAL SEPARATION RATE FOR THE INDUSTRY IS SHOWN IN THE BOX UNDER EACH CHART.

Separations

Resignation of the employee was the most common reason given for separations. For all respondents combined the separation rate between July 1967 and July 1968 was 8.1%. Two-thirds of these were resignations, while retirement accounted for 9.4%. The rest were scattered among deaths, discharges, layoffs, armed forces, and unspecified reasons. As usual, there were significant differences among the industries (Chart 8). The overall separation rate ranged from 14.0% in consulting to 4.0% in petroleum. Death or retirement was an important cause of separation in the transportation and utilities industries, less so in other areas. Discharge or layoff was highest in the construction, consulting, machinery, and electrical-electronics industries. Resignations were noticeably highest in aerospace and lowest in transportation, utilities, and the federal government. In the other areas resignations ranged between 54% and 69% of all separations. The complete breakdown is given in Table 6.

TABLE 6

ENGINEERING SEPARATIONS BY REASON

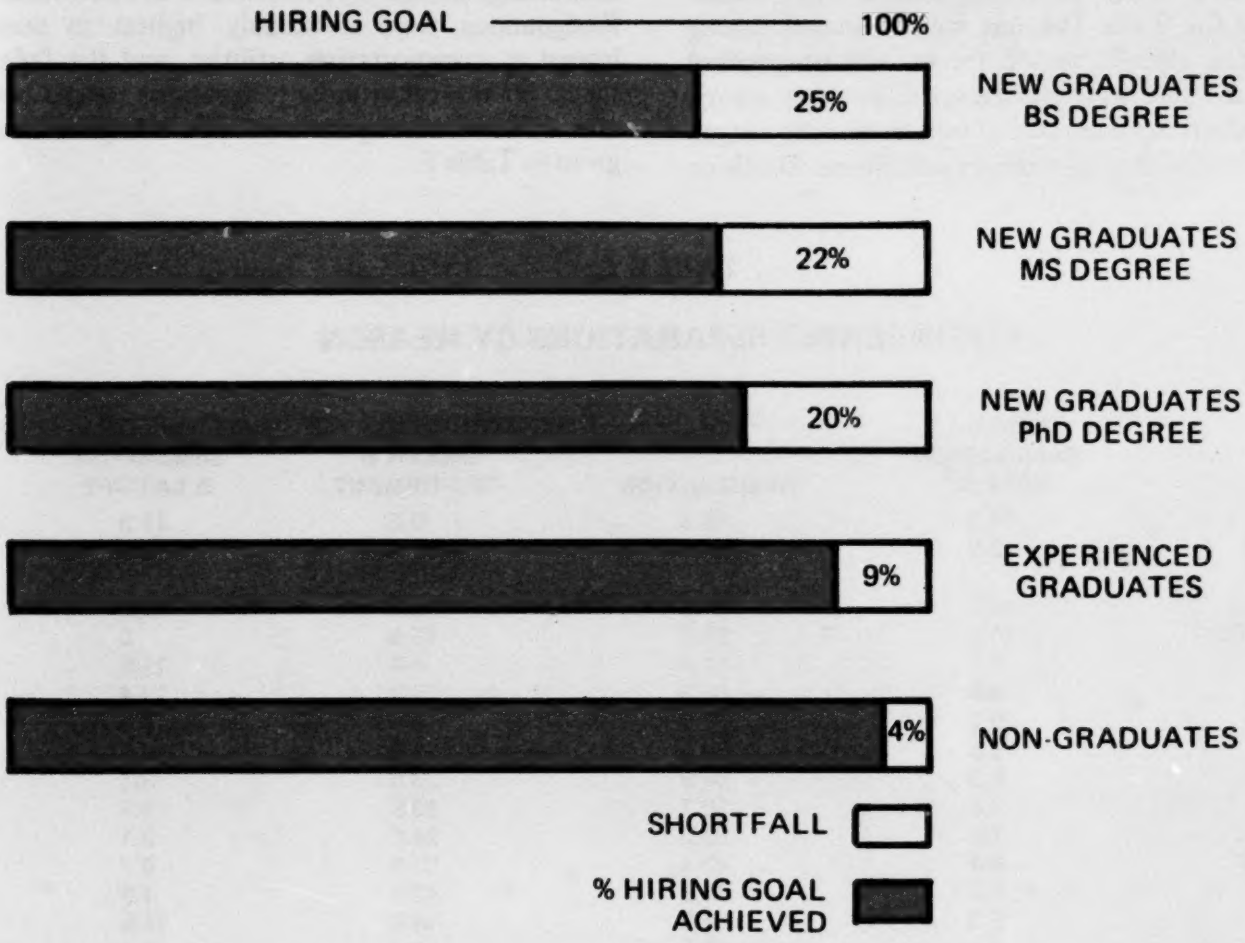
INDUSTRY	ANNUAL SEPARATION RATE,%[1]	% DISTRIBUTION FOR EACH REASON			
		RESIGNATION	DEATH & RETIREMENT	DISCHARGE & LAYOFF	OTHER
CONSULTING	14.0	65.8	9.0	17.3	7.9
CONSTRUCTION	12.3	64.2	10.6	18.8	6.4
ELECTRICAL & ELECTRONICS	10.3	67.3	6.8	15.2	10.7
TRANSPORTATION	10.0	31.8	45.5	0	22.7
AEROSPACE	9.8	81.0	4.4	12.8	1.8
OTHER MFG.	9.5	66.3	7.7	13.4	12.6
METALS	9.2	67.5	9.4	10.0	13.0
EDUCATION	8.8	54.5	11.9	8.4	25.2
LOCAL GOV'T	8.3	57.9	28.6	3.3	10.3
R & D	7.6	56.7	13.9	9.3	20.0
STATE GOV'T	7.5	63.3	24.6	2.1	9.8
FEDERAL GOV'T	6.4	47.4	23.5	0.7	28.5
UTILITIES	5.5	46.5	42.1	1.9	9.6
MACHINERY	5.3	61.9	18.6	15.8	3.8
CHEMICALS	5.1	62.6	17.9	9.1	10.4
PETROLEUM	4.0	69.0	16.1	6.4	8.5
ALL RESPONDENTS	8.1	66.2	12.5	11.0	10.2

Based on 882 returns from employers of 189,483 engineers.

[1] Number of terminations from July 1967 through June 1968 as a percent of engineering employment at the beginning of the period.

CHART 9

SHORTFALL IN ENGINEER HIRING GOALS FOR 1967-1968 BY EDUCATION OR EXPERIENCE LEVEL



Hiring Goals Planned and Achieved

Respondents generally fell between 19% and 25% below their planned hiring goals for new graduate engineers for 1968, with the greatest shortfall occurring at the bachelor's degree level (Chart 9). Nevertheless, employers were setting higher hiring goals for the forthcoming year, according to their returns. In the case of experienced engineering graduates and non-graduates employed as engineers, the shortfall was substantially lower and hiring goals for the next year were reduced. The figures (Table 7) suggest that the two latter categories are viewed as residual sources from which employers make up for some of the shortfall in new graduates. They also suggest that hiring goals for new graduates are consistently overoptimistic in view of current enrollment and degree trends, and that stated goals are higher than actual minimum requirements. Otherwise it would be difficult to understand how employers could function effectively in the face of shortfalls in all categories of engineers.

TABLE 7

COMPARISON OF HIRING OBJECTIVES FOR ENGINEERS AND NUMBER HIRED 1967 – 1968

	GOAL VERSUS ACTUAL 1967 – 1968			ACTUAL VERSUS PLANNED 1968 – 1969		
	GOAL	ACTUAL	SHORTFALL	ACTUAL	PLANNED	CHANGE
BACHELOR	9,646	7,227	25%	7,183	9,044	+26%
MASTER	1,646	1,291	22%	1,258	1,606	+28%
DOCTOR	882	703	20%	705	833	+18%
EXPERIENCED GRADUATES	9,385	8,499	9%	8,874	8,509	-4%
NON-GRADUATES	2,582	2,470	4%	2,529	2,426	-4%

To throw further light on the pervasiveness of the shortfall in engineering hires, Charts 10 and 11 show how the shortage or surplus of actual hires relative to planned hires was distributed among 431 manufacturing companies in the sample surveyed. These charts show that for 38.5% of the companies the shortfall ranged from 1 to 50 percent, but in most cases the shortage consisted of 1-9 engineers.

There is thus reason to believe that most of the shortfall manifested itself as the failure of a large number of companies to hire a few engineers apiece. It is reasonable to assume that even a small engineering department could handle a shortage of one or two people by internal means, such as working overtime or doubling up responsibilities temporarily. A great deal of additional study is needed, however, before we will begin to know how companies actually manage to get along in the face of apparently chronic shortages of technical manpower.

CHART 10

ACTUAL SHORTAGE OR EXCESS IN ENGINEER HIRES, 1967-1968

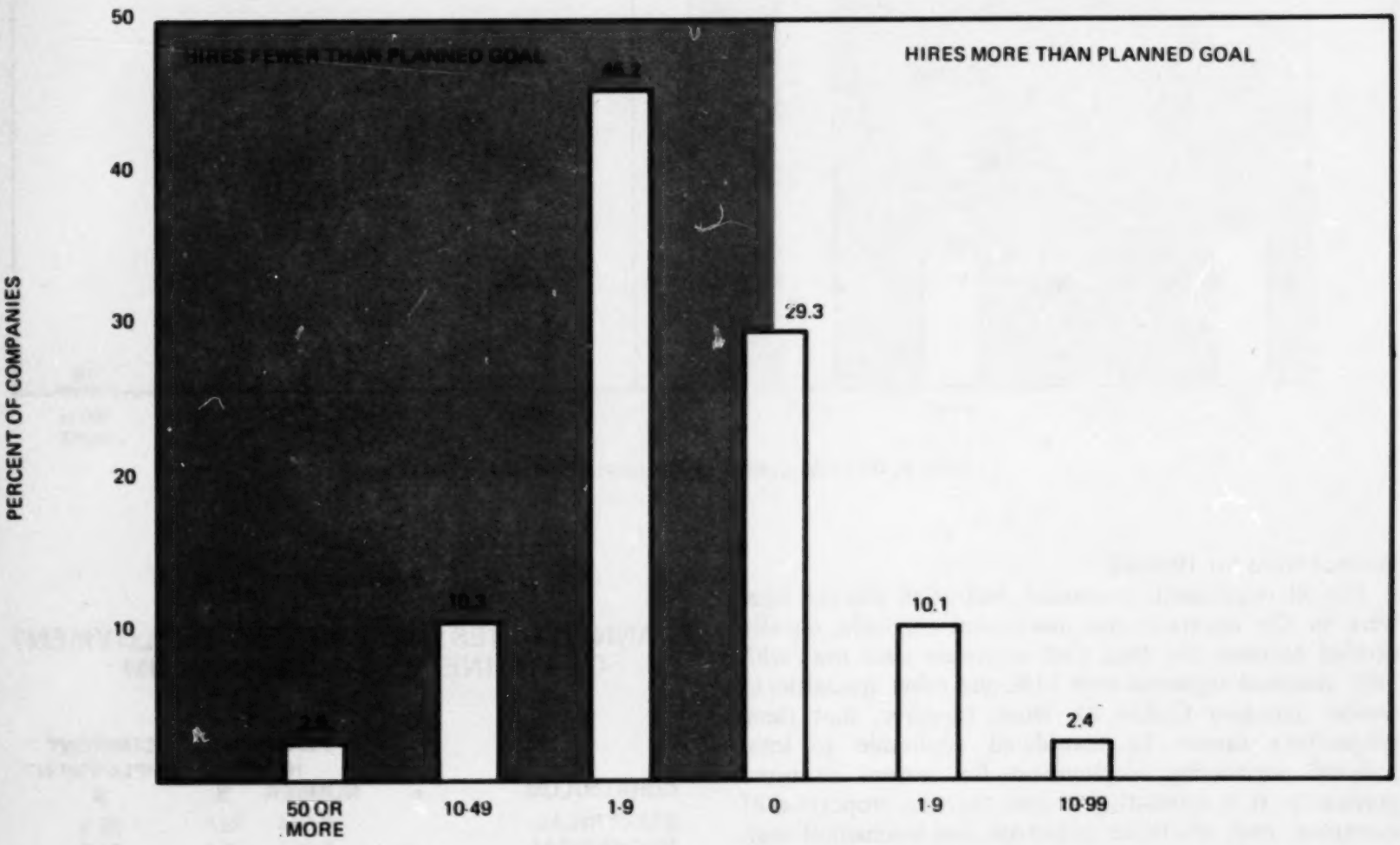
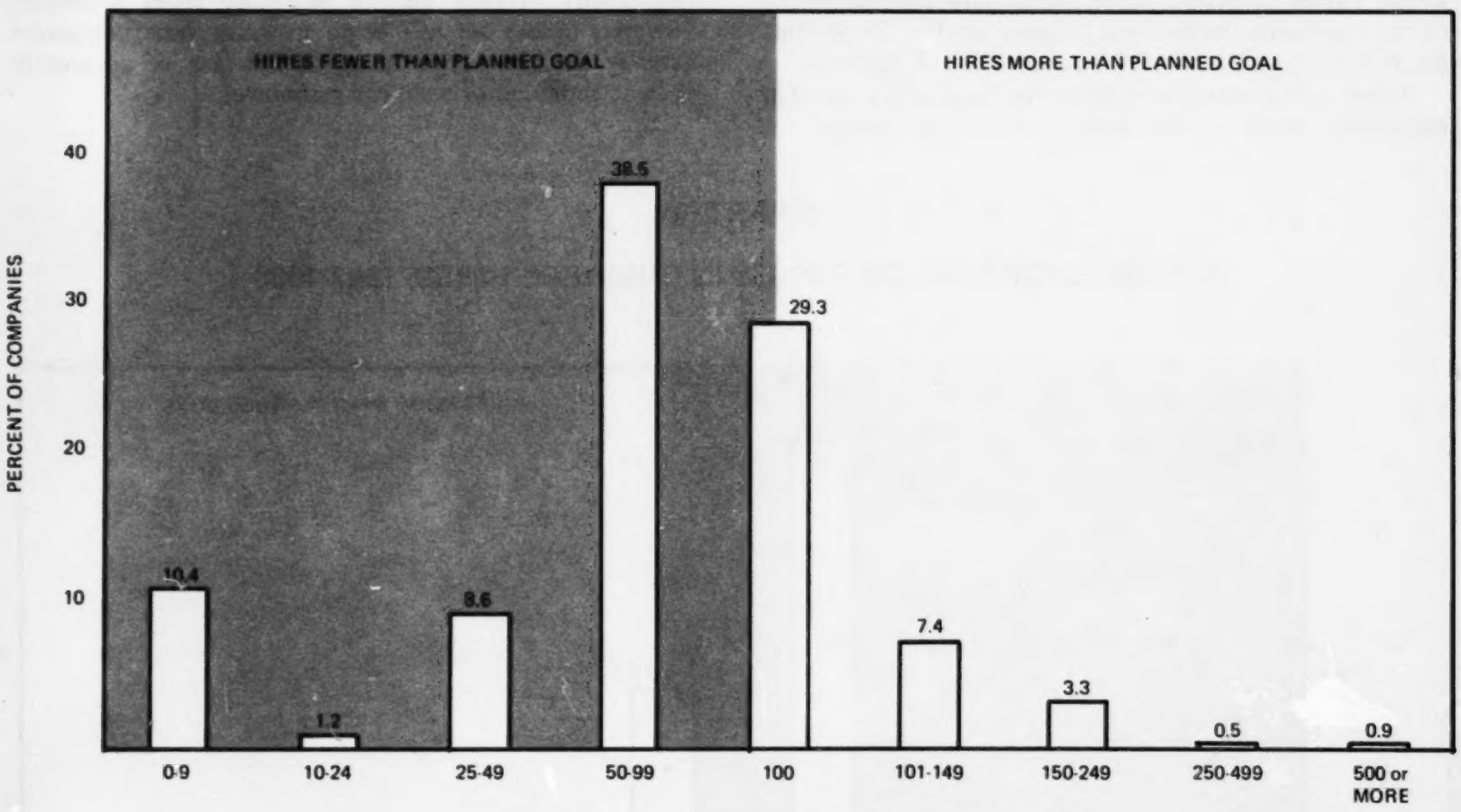


CHART 11

DEGREE OF SHORTAGE OR EXCESS IN ENGINEER HIRES AS A PERCENTAGE OF PLANNED GOAL



Planned Hires for 1968-69.

For all respondents combined, half of all planned hires were in the electrical and mechanical curricula, equally divided between the two. Civil engineers were next with 16%, chemical engineers with 11%, and other specialties in smaller numbers (Table 8). Note, however, that these proportions cannot be considered applicable to total national engineering employment for reasons discussed previously. It is interesting to note that the proportion of aerospace, civil, electrical, industrial, and mechanical engineering planned hires is higher than the proportional representation of these disciplines in total employment (from Table 2) while in the chemical and metallurgical specialties the proportions are lower. Since we are dealing with essentially the same employers in each case, these figures indicate in rough fashion the trend in demand for graduates of the various curricula. In the case of the "other" and "no specific curriculum required" categories,

TABLE 8

PLANNED HIRES AND CURRENT EMPLOYMENT OF ENGINEERS BY CURRICULUM

CURRICULUM	PLANNED HIRES NUMBER	PLANNED HIRES %	CURRENT EMPLOYMENT %
ELECTRICAL	5,984	28.6	25.9
MECHANICAL	5,257	25.1	24.7
CIVIL	3,587	17.2	16.5
CHEMICAL	1,976	9.4	11.3
AEROSPACE	1,189	5.7	5.1
INDUSTRIAL	948	4.5	4.3
METALLURGICAL	643	3.1	3.5
OTHER	792	3.8	4.3
NO SPECIFIC CURRICULUM REQ.	541	2.6	4.5
ALL RESPONDENTS	20,917	100	100

the figures indicate that employers are inclined to plan on hiring new engineers in specific disciplines but to find that they can be utilized somewhat more flexibly.

The proportion of planned hires by curriculum is of course strongly dependent on the nature of the industry. The detailed breakdown in Appendix Table 3 (page 31) should be studied for a better understanding of this subject.

In terms of job function, 40% of the new hires were expected to be for design work, and 16% each for production and research. Table 9 shows how the distribution of planned hires compares to that of currently employed engineers as taken from Table 3. Noticeably more new engineers are being hired for design work and fewer for management in proportion to the distribution of these functions in total employment. Differences in other functional areas are less apparent.

TABLE 9

PLANNED HIRES AND CURRENT EMPLOYMENT OF ENGINEERS BY FUNCTIONAL AREAS

FUNCTION	PLANNED HIRES NUMBER	%	CURRENT EMPLOYMENT %
DESIGN	8,326	40.2	33.3
PRODUCTION	3,401	16.4	15.0
RESEARCH	3,275	15.8	17.2
INSTALLATION	1,653	8.0	6.2
MANAGEMENT	996	4.8	11.6
SALES	972	4.7	4.7
QUALITY CONTROL	584	2.8	2.4
OTHER	1,477	7.1	9.5
TOTAL	20,684	100	100

Recruiting Experience of Employers.

Employers generally reported greater difficulty in hiring engineers at all levels in comparison with the previous year. New bachelor's degree graduates were rated most difficult, with experienced graduate engineers almost equally hard to find. Only a handful of respondents felt that recruiting in 1968 was easier than in 1967 (Table 10). Using new B.S. degree engineers as a base, a rough "index of difficulty" was calculated.[1]

Difficulty varied greatly from industry to industry. State and local government and transportation employers reported the greatest difficulty in hiring new bachelor's degree graduates, while the federal government and aerospace industry reported the least. The same pattern existed for master's and doctor's degrees, with the "other manufacturing" group also having considerable difficulty. Experienced engineers were hardest to come by in transportation, local governments, "other" manufacturing, and construction, while non-graduates were most difficult to hire in construction, consulting, and "other" manufacturing.

In the aerospace industry many companies reported less difficulty in hiring all levels of engineering personnel. Research and development also showed some signs of softness, as did the federal government, and to a lesser extent the electrical, chemical, and petroleum industries. Overall, however, the great majority of respondents in all groups reported the same or more difficulty, so that any softening of demand can only be characterized as spotty and relative rather than absolute. The complete breakdown is given in Appendix Table 4 on page 32.

TABLE 10

EMPLOYER'S SUBJECTIVE EVALUATION OF DIFFICULTY IN HIRING ENGINEERS 1968 COMPARED WITH 1967

	NO. REPLIES	PERCENT DISTRIBUTION MORE DIFFICULT	SAME	LESS DIFFICULT	"INDEX" (Note 1)
New B.S. engineering graduates	686	38	53	9	100
Experienced Engineers	728	36	53	11	87
New M.S. engineering graduates	504	34	60	7	66
New Doctor's degree engineering graduates	413	33	57	10	47
Non-graduates employed as engineers	520	24	61	15	25

[1]This index was computed by subtracting the percent reporting less difficulty from those reporting more difficulty and dividing the result by 29, which was the figure for new B.S. graduates, to convert all the numbers to a base of 100.

Technicians - Employment and Demand

Ratio of Technicians to Engineers

Replies disclosed a tremendous variation in the ratio of technicians per 100 engineers, ranging from a high of 162 in state governments to a low of 8 in the chemical industry. The ratio for all respondents was 55 per 100, but this should not be considered representative of total employment because the various industry groups reported in the survey are not represented in proportion to their place in total national employment. Note that the actual numbers of technicians reported in the transportation, petroleum, and construction industries were fairly small. Since statistics for these groups could be affected substantially by relatively small shifts in numbers from one category to another, they should be interpreted with due caution. Table 11 shows the ratios by industry for 1967 and 1968. While the ratios are generally comparable from one year to the next, they show both upward and downward movement depending on the industry. Construction in particular shows a decrease from 80 in 1967 to 68 in 1968. The other changes are probably due to local differences in employment within the responding companies, and should not be interpreted as representing industry-wide trends because there is no assurance that the data are reliable enough for such a purpose.

TABLE 11

RATIO OF TECHNICIANS TO ENGINEERS BY INDUSTRY, 1967 AND 1968

INDUSTRY	TECHNICIANS PER 100 ENGINEERS JULY 1, 1967	JULY 1, 1968
STATE GOV'T	162	161
CONSTRUCTION	80	68
METALS	75	71
R & D	69	68
ELECTRICAL & ELECTRONICS	68	69
LOCAL GOV'T	67	70
UTILITIES	67	66
TRANSPORTATION SERVICES	61	65
CONSULTING	60	58
ALL RESPONDENTS	55	54
PETROLEUM	51	51
MACHINERY	49	46
FEDERAL GOV'T	42	41
OTHER MFG.	36	38
AEROSPACE	31	28
EDUCATION	19	20
CHEMICALS	8	9

Employment by Curriculum

Civil engineering technology represents the largest curriculum group for employed technicians reported by survey respondents, with the electrical group almost as large (Chart 12). Third largest is drafting. These three fields together make up 70% of the total. The remaining 30% consists of mechanical, chemical, and other smaller fields of engineering technology. The overall distribution for technicians is quite different from that for engineers, in line with the previous finding that the engineer-technician ratio can be expected to vary significantly from one specialty to another.

The concentration of curricular fields also varies widely from industry to industry. Chemical technicians are heavily

TABLE 12

CURRICULUM DISTRIBUTION OF TECHNICIANS BY INDUSTRY

INDUSTRY	NO.OF RESP.	NO.TECH. EMP. BY RESPOND.	PERCENT OF EMPLOYED TECHNICIANS BY CURRICULUM CHEM.	CIVIL	DRAFT.	ELECT.	INDUS.	MATH	MECH.	PHYS. SCIENCE	OTHER	TOTAL
AEROSPACE	17	8,306	2.1	2.5	31.8	27.9	1.2	7.5	15.6	7.5	4.0	100
CHEMICAL	29	1,077	79.7	0.2	4.2	1.3	0.6	4.8	4.9	3.5	0.7	100
CONSTRUCTION	25	629	4.8	31.3	36.6	1.3	10.0	2.5	2.9	8.3	2.4	100
CONSULTING	56	2,505	2.4	40.6	37.8	4.5	2.0	1.7	10.1	0.1	1.0	100
ELECTRICAL & ELECTRONICS	73	6,960	1.0	0.2	6.4	73.2	1.3	5.7	9.3	0.5	2.7	100
MACHINERY	66	2,821	3.3	1.0	35.8	10.6	4.7	1.4	41.2	0.8	1.5	100
METALS	64	1,886	15.8	4.6	29.0	6.3	7.9	6.6	12.5	9.6	7.6	100
OTHER MFG.	82	6,260	19.7	1.1	13.6	14.6	3.5	2.1	20.6	4.3	20.5	100
PETROLEUM	13	435	12.8	0	36.2	15.4	0	9.4	4.1	16.5	5.5	100
R & D	23	5,368	15.6	0.7	3.1	53.7	0.2	5.3	11.3	6.4	3.7	100
TRANSPORTATION	8	306	1.3	22.2	13.4	27.4	0.7	2.0	32.3	0.7	0	100
UTILITIES	63	4,863	3.2	3.9	20.3	58.8	0.5	1.0	10.3	0.3	1.8	100
FEDERAL GOV'T	7	2,200	8.2	9.5	14.8	31.7	1.7	4.0	8.5	16.8	4.6	100
STATE GOV'T	22	18,332	1.8	81.4	12.2	0.3	0.1	1.5	0.9	0.9	1.0	100
LOCAL GOV'T	30	1,683	0.4	36.7	40.8	16.9	0	1.4	0.7	*	3.1	100
EDUCATION	80	1,345	9.4	5.8	3.1	30.6	4.2	4.7	21.3	10.2	10.6	100
ALL RESPONDENTS	658	64,976	6.9	27.2	17.5	25.0	1.5	3.5	10.5	3.6	4.3	100

*Less than 0.1%
Totals may not add to 100% due to rounding.

predominant in the chemical industry, and well represented in the metals, R & D, and petroleum categories. Civil engineering technicians dominate in the state governments, are the largest single group in the consulting field, and are strong in local governments, construction, and transportation. Drafting technicians are very strong in local governments, construction, consulting, machinery, petroleum, aerospace, metals, and utilities.

Electrical and electronic technicians make up a majority in the electrical and electronics, utilities, and R & D industries, and are important in the federal government, education, aerospace, and transportation. Mechanical engineering technicians are heavily employed in the machinery manufacturing and transportation industries and in education.

Industrial engineering, mathematical, physical science, and other technicians are minor factors in all but a few specific instances. Table 12 shows the full curriculum distribution of technicians by industry.

Employment by Function

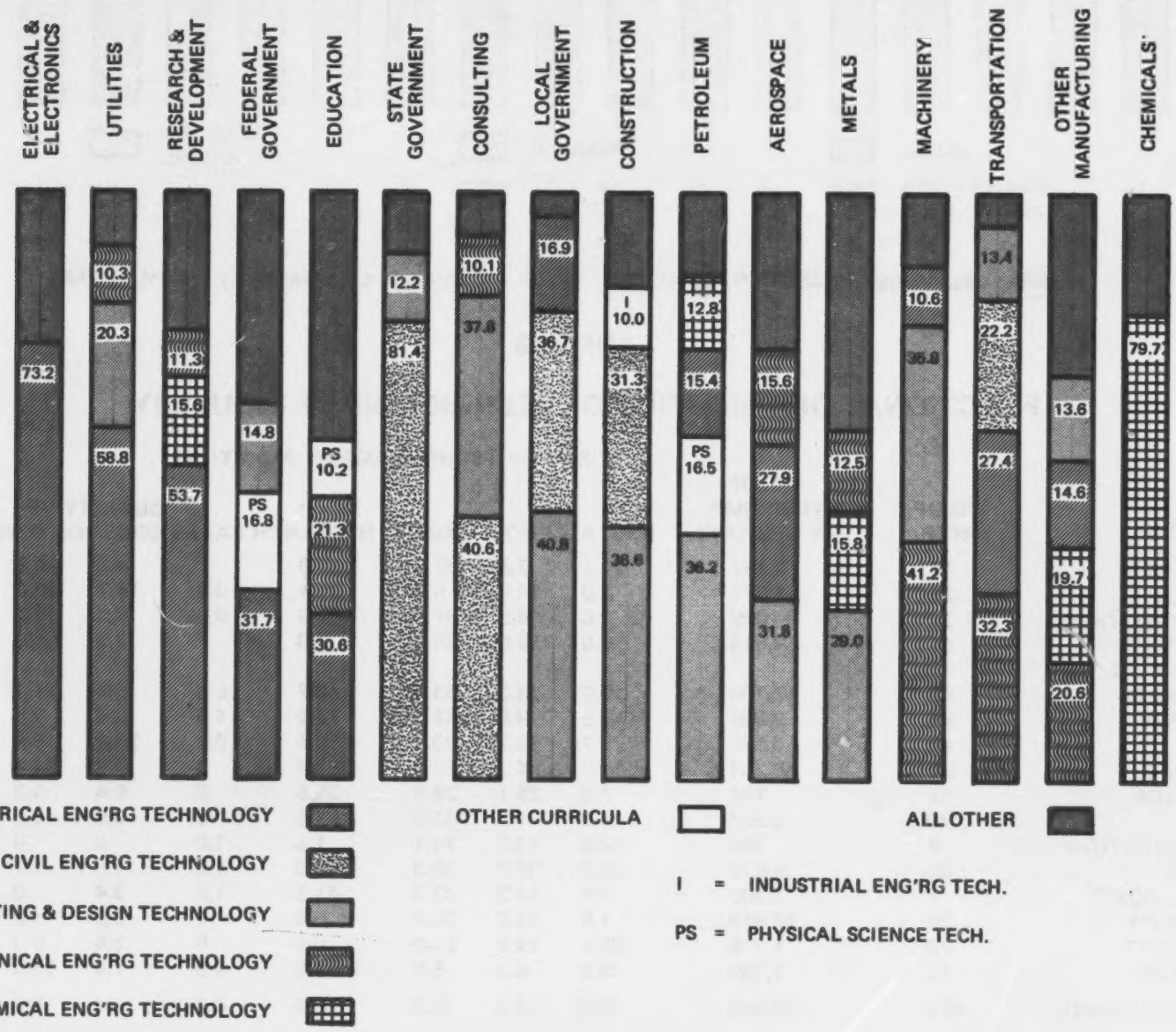
Design is the function performed by the largest number of technicians reported in this survey, followed by production, research, and installation. All other functions together account for less than 10% of technician employment. Chart 13 on page 22 gives the highlights of employment by function.

On an industry basis, design is highly important in all categories except education and chemicals, and is the majority function for technicians in construction, consulting, and the electrical industry. Research is the largest functional area in education, chemicals, R & D, federal government and petroleum. Installation is most important in the transportation industry and local governments while production is the largest functional area in state governments and utilities. Surprisingly enough, sales is a negligible function for all types of employer, and quality control utilizes a very small proportion of technicians in all industries except metals and chemicals.

The complete breakdown of technician functions by industry is given in Table 13 on page 22.

CHART 12

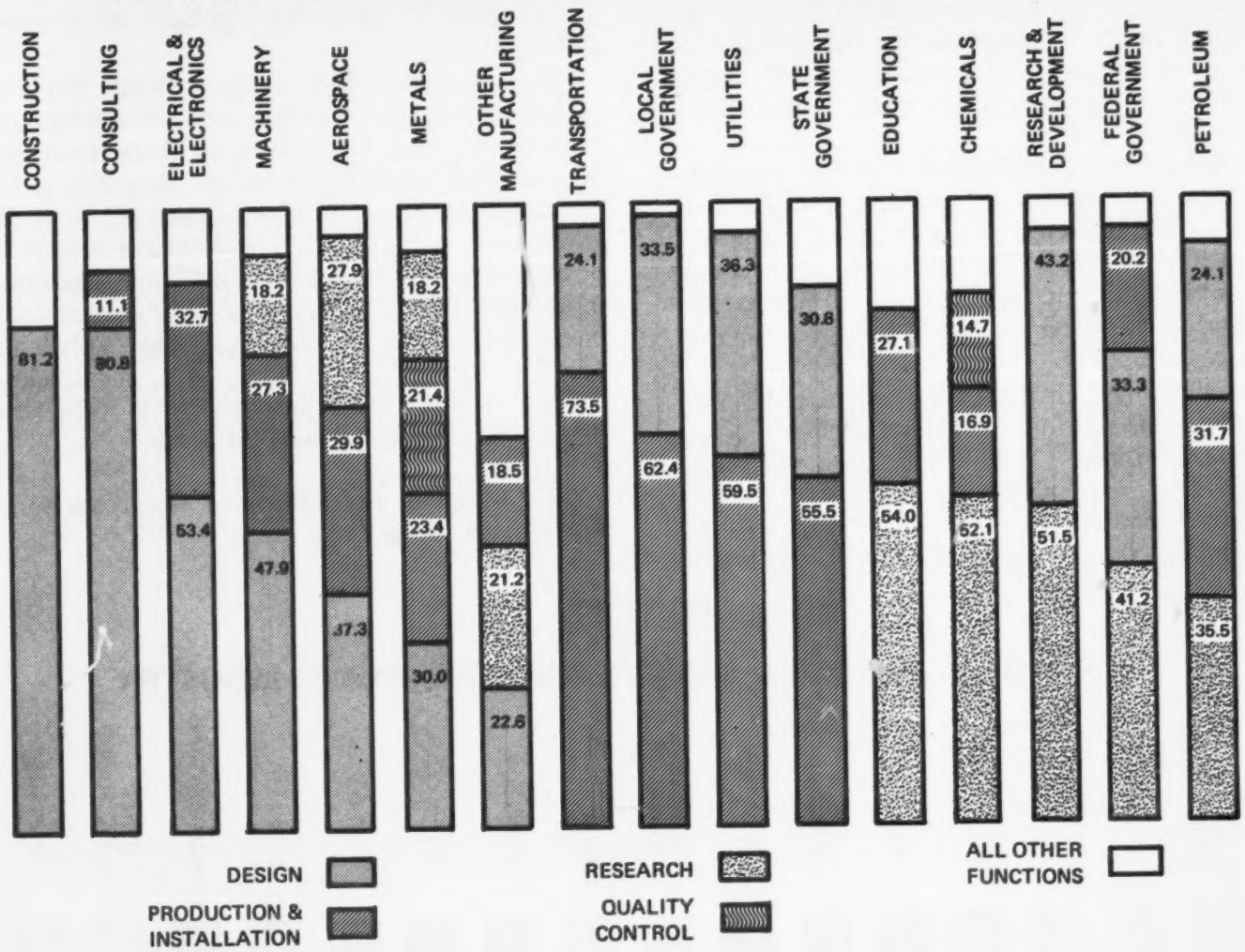
DISTRIBUTION OF TECHNICIANS BY CURRICULUM AND INDUSTRY



NOTE: ONLY THOSE ACCOUNTING FOR AT LEAST 10% OF THE TOTAL IN EACH INDUSTRY ARE INDICATED.

CHART 13

DISTRIBUTION OF TECHNICIANS BY FUNCTION AND INDUSTRY



NOTE: ONLY THOSE ACCOUNTING FOR AT LEAST 10% OF THE TOTAL IN EACH INDUSTRY ARE INDICATED.

TABLE 13

FUNCTIONAL DISTRIBUTION OF TECHNICIANS BY INDUSTRY

INDUSTRY	NO.OF RESP.	NO. OF TECH.EMP. BY RESPOND.	PERCENT OF TECHNICIANS BY FUNCTION							
			INSTAL.	PROD.	DESIGN	RESEARCH	SALES	QUALITY CONTROL	OTHER	TOTAL
AEROSPACE	15	8,187	22.1	7.8	37.3	27.9	*	4.3	0.5	100
CHEMICAL	25	1,077	2.0	14.9	5.6	52.1	0.9	14.7	10.0	100
CONSTRUCTION	26	925	1.5	6.5	81.2	1.9	0.8	7.0	0.1	100
CONSULTING	54	2,513	0.6	10.5	80.8	2.3	*	3.9	1.7	100
ELECTRICAL & ELECTRONICS	68	12,704	19.2	13.5	53.4	6.7	0.6	5.4	1.1	100
MACHINERY	64	2,829	17.5	9.8	47.9	18.2	1.5	2.4	2.5	100
METALS	60	1,878	7.7	15.7	30.0	18.2	0.5	21.4	6.4	100
OTHER MFG.	80	6,284	14.2	4.3	22.6	21.2	*	3.3	34.4	100
PETROLEUM	12	772	6.6	25.1	24.1	35.5	0	8.4	0.3	100
R & D	23	5,393	1.3	1.6	43.2	51.5	0	0.5	1.9	100
TRANSPORTATION	8	306	59.8	13.7	24.1	1.3	1.0	0	0	100
UTILITIES	60	5,526	22.3	37.2	36.3	0.6	1.2	1.6	1.1	100
FEDERAL GOV'T	7	2,202	7.0	13.2	33.3	41.2	1.8	3.4	0	100
STATE GOV'T	20	16,913	1.9	53.6	30.8	5.8	0	3.9	4.0	100
LOCAL GOV'T	28	1,716	37.9	24.5	33.5	0.5	0	2.6	0.9	100
EDUCATION	73	1,380	18.2	8.9	5.0	54.0	1.0	1.4	11.4	100
ALL RESPONDENTS	623	70,605	12.4	22.6	38.5	16.5	0.4	4.2	5.2	100

*Less than 0.1%
Totals may not add to 100% due to rounding.

Growth of Technician Employment

For the 576 employers who gave usable data on this part of the survey, technician employment increased only 3.0% for the year ending July 1, 1968. This is less than the growth of engineering employment reported earlier in this study, and is also less than indicated by earlier EMC surveys and by U.S. Department of Labor projections. A possible explanation is that fairly large numbers of technicians are being upgraded to engineering jobs or are earning engineering degrees through part-time and evening study. Although this hypothesis cannot be proved from the present survey, the fact that responding employers reported hiring 3,000 non-graduates as engineers is evidence that upgrading is taking place, and presumably technicians would be ideal candidates for such promotion. The loss of 3,000 technicians by upgrading out of a technician work force of about 70,000 (the numbers covered by this survey) would make a noticeable difference in the annual growth rate.

As with engineering employment, technician growth varied widely by industry, as indicated by Table 14. Growth was highest in chemicals and transportation, insignificant in aerospace and machinery, and negative in construction. It is interesting to compare these figures with those for engineers (Table 4) and observe how little correlation there is between the two groups. In the chemical industry, for instance, where the ratio of engineers to technicians is eleven to one, the growth rate for engineers is low, and for technicians high, but there are many more engineers employed in this industry than technicians. In aerospace, where engineers outnumber technicians three to one, the growth rates are reversed. In industries with a high ratio of technicians to engineers, such as state governments, construction, and metals (Table 11), growth rates tend to be lower, but the pattern is far from consistent.

TABLE 14

CHANGE IN TECHNICIAN EMPLOYMENT BY INDUSTRY, 1967 to 1968

INDUSTRY	TECHNICIANS EMPLOYED JULY 1, 1967	JULY 1, 1968	CHANGE
CHEMICALS	1,196	1,354	13.2
TRANSPORTATION	273	305	11.7
OTHER MFG'ING	1,659	1,821	9.8
EDUCATION	1,181	1,277	8.1
CONSULTING	2,212	2,385	7.8
LOCAL GOV'T	1,372	1,450	5.7
ELECTRICAL & ELECTRONICS	12,771	13,368	4.7
R & D	4,817	4,998	3.8
UTILITIES	4,728	4,878	3.2
PETROLEUM	2,196	2,250	2.5
STATE GOV'T	17,219	17,646	2.5
FEDERAL GOV'T	2,164	2,207	2.0
METALS	5,905	6,000	1.6
MACHINERY	2,232	2,251	0.9
AEROSPACE	8,538	8,547	0.1
CONSTRUCTION	1,138	954	-16.2
ALL RESPONDENTS	69,601	71,691	3.0

Based on replies from 576 employers.

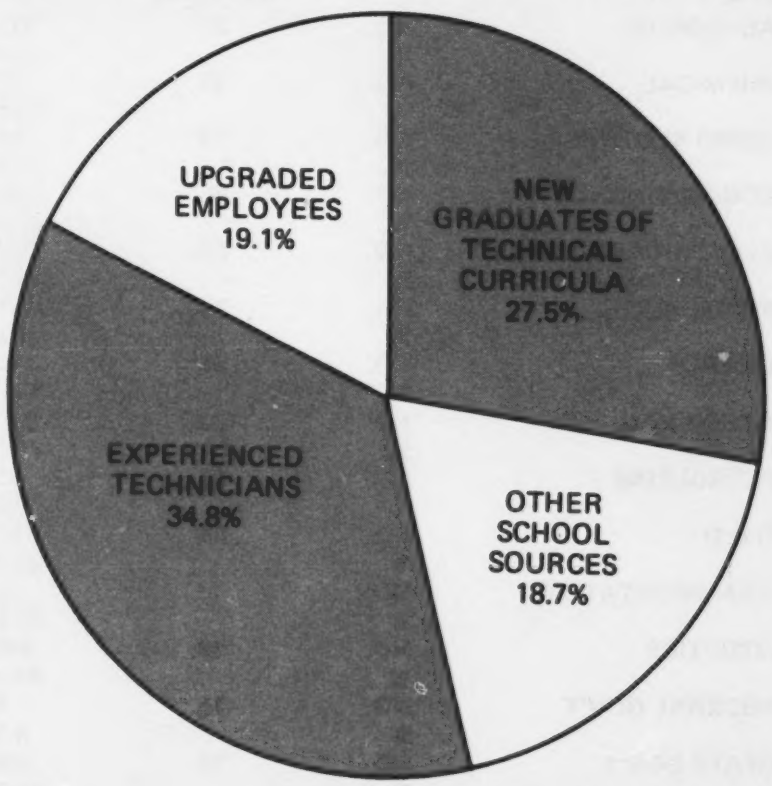
It appears from these figures that the growth of technician employment cannot automatically be assumed to depend on engineering employment in the same industry. More likely there are short term shifts taking place in the engineer-technician ratio because of changing business conditions, and longer term changes based on technological factors, further confused by local supply-demand relationships in the labor market. The relative degree to which technicians have already penetrated an industry is undoubtedly another factor affecting current ratios of technicians to engineers.

New Hires

Replies from 926 employers reporting new technician hires broke down as shown in Chart 14.

CHART 14

DISTRIBUTION OF NEW TECHNICIAN HIRES BY EDUCATION OR EXPERIENCE LEVEL


UPGRADED EMPLOYEES 19.1%
NEW GRADUATES OF TECHNICAL CURRICULA 27.5%
EXPERIENCED TECHNICIANS 34.8%
OTHER SCHOOL SOURCES 18.7%

Overall, the pattern was similar to that for engineers (page 13) but with more reliance on upgrading and less on hiring experienced people on the open market. Only 65% of the hires actually represented the addition of new people to the technician supply, as the hiring of experienced technicians from one company to another is, in a way, robbing Peter to pay Paul. The 18.7% of new technicians from school sources other than regular technical curricula could include non-graduates of engineering programs, graduates of general junior college courses, and similar people. These plus upgraded employees constitute 38% of the total new technician input. The fact that so many technicians are hired without having the formal academic preparation obtained through completion of a recognized technical curriculum is an indication of a shortage of fully-qualified graduates. It also points up the difficulty of establishing firm job definitions and qualifications for the technician group as a whole, when so much current employment of

technicians seems to be a matter of "making do" with whatever people are available rather than hiring people to meet firm job standards.

As usual, there were wide variations in the hiring patterns of different employer groups. New technical school graduates were most important as a manpower source in metals, utilities, machinery, chemicals, and the electrical industry and least important in the federal government and the petroleum industry. Upgrading was most prevalent in the transportation, petroleum, and electrical industries and the federal government, but little used in education and research. Experienced technicians were the source of more than half of all new hires in construction, education, local government, and consulting, and were important in all other areas except transportation, and to a lesser extent, utilities and chemicals. The patterns revealed by Table 15 are difficult to explain on any basis other than "the practice of the industry" and again point up the complexity of the technician group in the overall manpower picture.

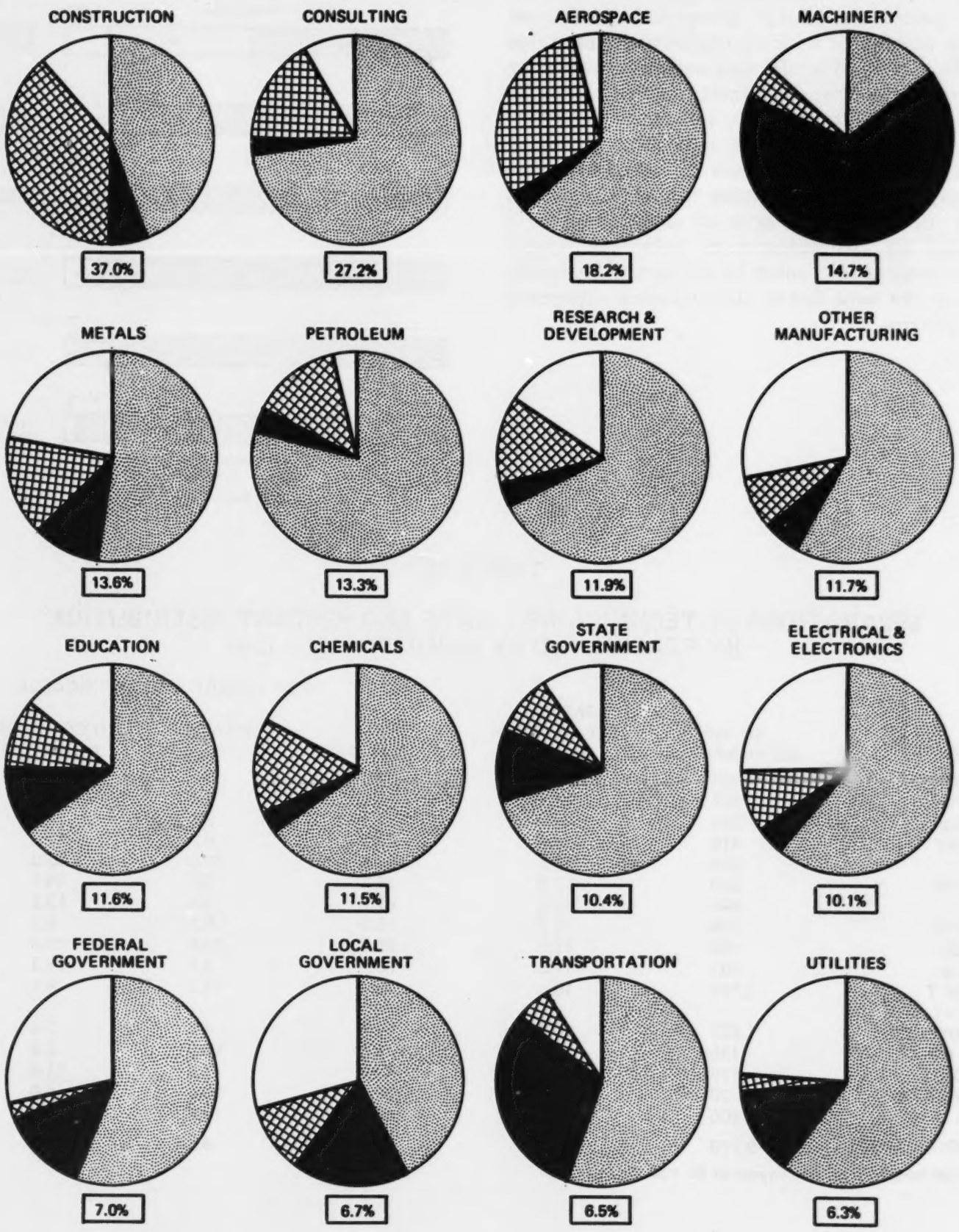
TABLE 15

NEW HIRES OF TECHNICIANS BY TYPE OF TRAINING AND INDUSTRY JULY 1967 – JULY 1968

			TYPE OF PRE-HIRE TRAINING				
INDUSTRY		NO. OF RETURNS	NEW GRADS	OTHER SCHOOL	UP-GRADED	EXPERI-ENCED	TOTAL
AEROSPACE	NO.	23	328	177	172	523	1,200
	%		27.4	14.7	14.3	43.6	100
CHEMICAL	NO.	39	82	69	50	30	231
	%		35.5	29.9	21.6	13.0	100
CONSTRUCTION	NO.	53	22	10	21	128	181
	%		12.2	5.5	11.6	70.7	100
CONSULTING	NO.	68	142	128	87	448	805
	%		17.6	15.9	10.8	55.7	100
ELECTRICAL & ELECTRONICS	NO.	86	908	328	781	539	2,556
	%		35.5	12.8	30.5	21.1	100
MACHINERY	NO.	77	181	92	64	124	461
	%		39.2	20.0	13.9	26.9	100
METALS	NO.	88	210	89	80	106	485
	%		43.3	18.4	16.5	21.9	100
OTHER MFG.	NO.	123	214	177	113	351	855
	%		25.0	20.7	13.2	41.0	100
PETROLEUM	NO.	27	35	60	161	169	425
	%		8.2	14.1	37.9	39.8	100
R & D	NO.	25	197	147	48	322	714
	%		27.6	20.6	6.7	45.1	100
TRANSPORTATION	NO.	16	15	8	29	2	54
	%		27.8	14.8	53.7	3.7	100
UTILITIES	NO.	83	345	270	140	87	842
	%		41.0	32.1	16.6	10.3	100
FEDERAL GOV'T	NO.	15	8	29	39	75	151
	%		5.3	19.2	25.8	49.7	100
STATE GOV'T	NO.	26	359	500	353	762	1,974
	%		18.2	25.3	17.9	38.6	100
LOCAL GOV'T	NO.	42	51	18	37	168	274
	%		18.6	6.6	13.5	61.3	100
EDUCATION	NO.	135	48	33	12	150	243
	%		19.8	13.6	4.9	61.7	100
ALL RESPONDENTS	NO.	926	3,145	2,135	2,187	3,984	11,451
	%		27.5	18.7	19.1	34.8	100

CHART 15

TECHNICIAN SEPARATIONS BY INDUSTRY AND REASON



ANNUAL SEPARATION RATE FOR THE INDUSTRY IS SHOWN IN THE BOX UNDER EACH CHART.

Separations

The overall separation rate for all respondents was 12.1%, or about half again as great as for engineers. Resignation was by far the most common cause of technician separations, accounting for nearly two-thirds of the total (Chart 15 on page 25). Deaths and retirements were fewer (as would be expected in a younger group) and layoffs more numerous in comparison with the engineers' statistics (see Table 6). Discharges and layoffs were noticeably high in the construction and aerospace industries, which traditionally hire people for particular projects, and low in the federal government, utilities, and transportation. The pattern of technician separations on an industry by industry basis did not show any consistent relationship to that for engineers (Table 16). In this finding, as in so many others, it is apparent that the characteristics of technicians deserve independent analysis and cannot be assumed to be equally dependent on the same factors that influence engineering manpower patterns.

CHART 16

SHORTFALL IN TECHNICIAN HIRING GOALS FOR 1967-1968 BY EDUCATION OR EXPERIENCE LEVEL

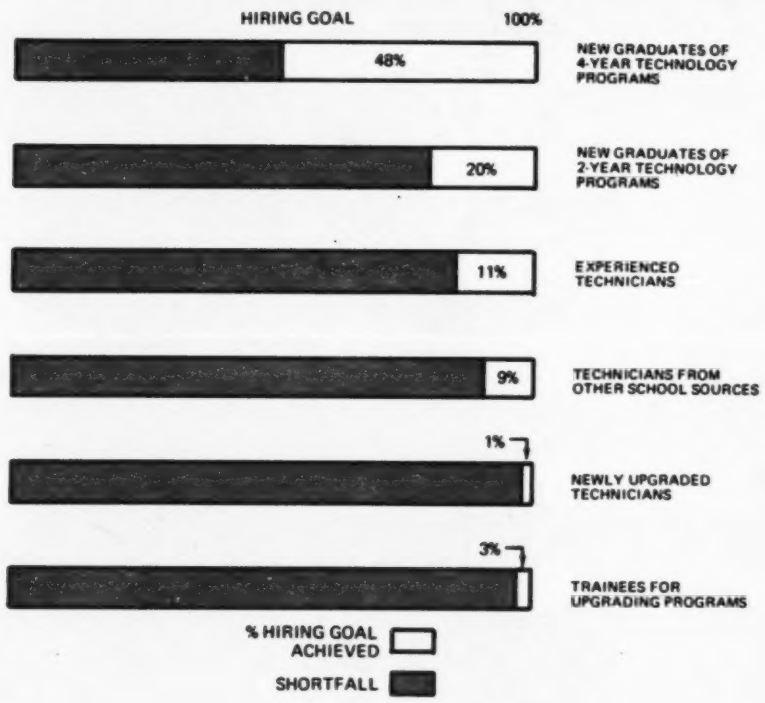


TABLE 16

SEPARATIONS OF TECHNICIANS – RATE AND PERCENT DISTRIBUTION BY REASON AND BY INDUSTRY 1967-1968

INDUSTRY	NO. OF SEPARATIONS	ANNUAL SEPARATION RATE, %	% OF SEPARATIONS BY REASON: RESIGNATION	DEATH & RETIREMENT	DISCHARGE & LAYOFF	OTHER
CONSTRUCTION	358	37.0	45.0	5.3	37.4	12.3
CONSULTING	697	27.2	72.5	2.0	17.0	8.5
AEROSPACE	1,559	18.2	62.9	2.5	29.1	5.5
MACHINERY	418	14.7	67.7	6.5	15.3	10.5
METALS	284	13.6	52.8	10.0	15.3	21.9
PETROLEUM	333	13.3	78.1	3.9	14.7	3.3
R & D	646	11.9	67.2	3.4	13.2	16.2
OTHER MFG.	738	11.7	58.0	5.6	8.7	27.7
EDUCATION	169	11.6	65.0	10.0	10.6	14.4
CHEMICALS	161	11.5	65.1	3.1	14.3	17.5
STATE GOV'T	2,190	10.4	70.1	11.2	9.1	9.6
ELECTRICAL & ELECTRONICS	1,527	10.1	61.1	4.0	9.8	25.1
FEDERAL GOV'T	155	7.0	55.6	13.0	2.6	28.8
LOCAL GOV'T	118	6.7	41.5	17.8	11.0	29.7
TRANSPORTATION	20	6.5	55.0	30.0	5.0	10.0
UTILITIES	405	6.3	60.0	13.6	2.5	23.9
ALL RESPONDENTS	9,778	12.1	64.3	6.6	14.2	14.9

Based on 658 returns from employers of 81,134 technicians.

Planned Versus Actual Hires

Employers fell 48% short of achieving their planned hires of four-year technology graduates and 20% short for two-year technical school graduates. They also experienced a shortfall of 11% in experienced technicians (Chart 16). Despite this experience they planned to hire from 12% to 48% more employees in corresponding categories in the forthcoming year (Table 17).

In the case of upgraded employees and trainees, goals and actual hires were practically in balance. This is not surprising since both these categories are largely within the employer's direct control. If a company plans to upgrade or promote a specific number of its employees, it is unlikely that it will fall very far short of its intended goal as it can adjust either the input or the output of its training program relatively easily.

Actual hires in the "other school source" category were only 9% short of plans. The figures suggest that "other schools" and company upgrading programs represent a flexible residual source from which employers can make up for shortfalls in their formal technical graduate hires.

Planned hires for 1968-69 counted heavily on new graduates and experienced technicians, while only a minor increase was contemplated in the number of employees to be trained or upgraded. In view of actual experience, employers would seem to have reason to increase these internal programs by a substantial amount. Perhaps the educational requirements of the in-house training programs are already so stringent that major expansion would be impractical. This is a question that deserves careful study. If technician work in fact requires the equivalent of two years of college education, it is indeed unrealistic to expect employers to provide this much formal training to upgrade the average high school graduate, let alone "dropouts" or other hard-core employees.

Table 18 is a comparison of planned hires and existing distribution by curriculum. The percentage of planned hires in the major curricula is higher for electrical and mechanical and lower for civil engineering technicians than the respective percentage for all employed technicians. This probably is a reflection of short term economic conditions in specific

TABLE 17

COMPARISON OF HIRING OBJECTIVES FOR TECHNICIANS AND NUMBER HIRED 1967-1968

	HIRING GOAL VERSUS ACTUAL HIRES 1967-1968[1]			ACTUAL HIRES 1967-1968 VERSUS PLANNED HIRES 1968-1969[2]		
	GOAL	ACTUAL	SHORTFALL	ACTUAL	PLANNED	INCREASE
4–YEAR TECHNOLOGY GRADUATES	323	168	48%	231	342	48%
2–YEAR TECHNICAL SCHOOL GRADUATES	3,187	2,519	20%	2,482	3,269	32%
OTHER SCHOOL SOURCES	1,473	1,338	9%	1,750	1,979	13%
EXPERIENCED TECHNICIANS	2,885	2,571	11%	3,127	3,505	12%
NEWLY UPGRADED TECHNICIANS	878	870	1%	1,311	1,372	4%
TRAINEES	2,647	2,556	3%	2,878	3,045	6%

[1] Based on replies from 852 employers covering 10,022 hired technicians.

[2] Based on replies from 897 employers covering 11,779 hired technicians.

TABLE 18

PLANNED HIRES OF TECHNICIANS BY CURRICULUM, 1968–1969

CURRICULUM	NUMBER	% OF PLANNED HIRES	% OF ALL EMPLOYED TECHNICIANS
ELECTRICAL	3,501	29.0	25.0
CIVIL ENGINEERING	2,680	22.2	27.2
DRAFTING	2,156	17.9	17.5
MECHANICAL	1,517	12.6	10.5
CHEMICAL & RELATED	726	6.0	6.9
MATHEMATICAL	626	5.2	3.5
PHYSICAL SCIENCE	275	2.3	3.6
INDUSTRIAL	240	2.0	1.5
OTHER	340	2.8	4.3
TOTAL	12,061	100	100

industry groups covered by the survey. For example, the reduced employment in construction evident from Table 14 would affect new hires of civil engineering technicians. A more detailed study industry by industry, which is beyond the scope of this report, would be required to resolve questions such as this.

By job function, 40% of all planned new hires were in the field of design, 22% in production, and 17% in research. Table 19 shows the functional distribution of planned hires compared to currently employed technicians (from Table 13.) Overall there is practically no difference between the two distributions, thus indicating that technicians can generally expect to stay in the functional area for which they were originally hired.

Charts 17 and 18 illustrate the extent to which the shortfall in technician hires was distributed among the

TABLE 19

PLANNED HIRES OF TECHNICIANS BY FUNCTIONAL AREA 1968 – 1969

FUNCTION	NUMBER	% OF PLANNED HIRES	% OF ALL ENGINEERING TECHNICIANS
DESIGN	4,628	40.4	38.5
PRODUCTION	2,498	21.8	22.6
RESEARCH	1,992	17.4	16.5
INSTALLATION	1,171	10.2	12.4
QUALITY CONTROL	581	5.1	4.2
SALES	62	0.5	0.4
OTHER	526	4.6	5.2
TOTAL	11,458	100	100

CHART 17

ACTUAL SHORTAGE OR EXCESS IN TECHNICIAN HIRES, 1967-1968

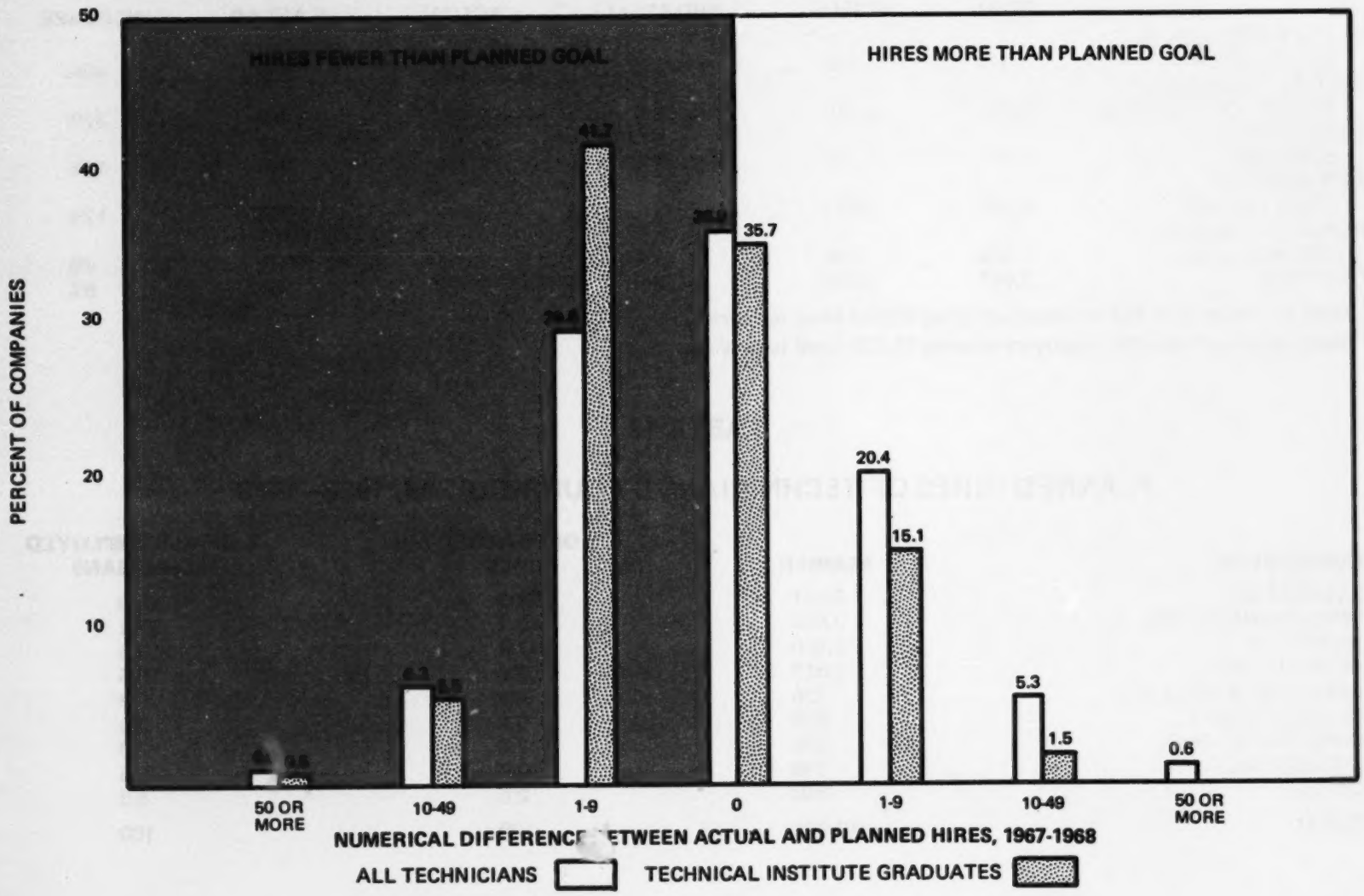
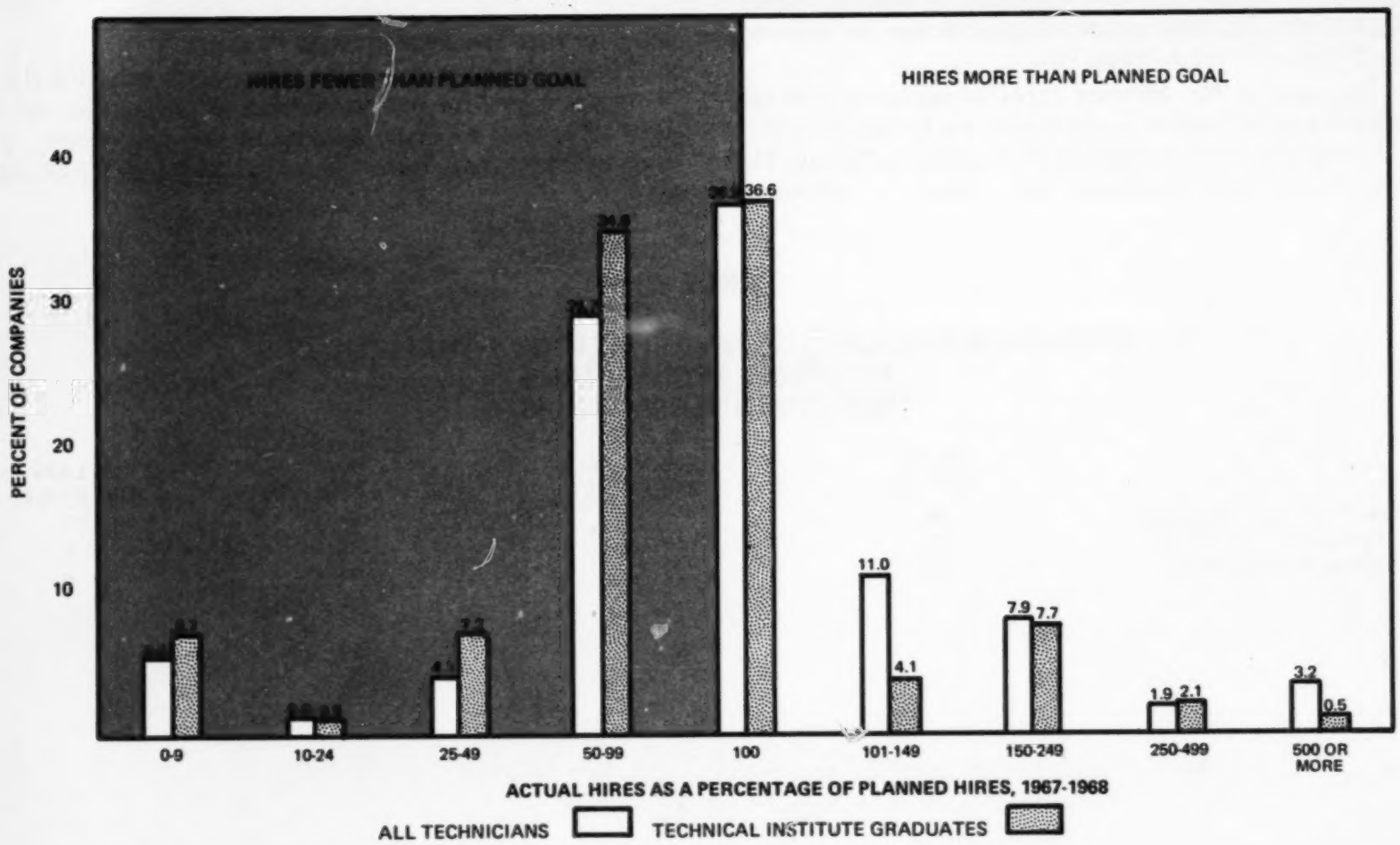


CHART 18

DEGREE OF SHORTAGE OR EXCESS IN TECHNICIAN HIRES AS A PERCENTAGE OF PLANNED GOAL



responding employers. In the case of all technician hires, 37% of the employers recorded shortfalls in their hiring goals, but a larger group reported no shortage or even a surplus. In terms of new technical institute graduates, however, 48% of the employers fell short of their planned objectives. Further, in 26% of the companies the shortage was such that only one-half to three-fourths of their hiring goals were reached. Thus the shortfall of technician hires, like that of engineers, consists of a relatively small number of individuals in a large number of companies.

The unusually wide dispersion in the case of new technical institute graduates, ranging from extreme shortage to substantial surplus, seems to indicate that local factors are very important in the technician labor market. Probably companies in areas where there are strong technical institutes are able to meet or exceed their hiring goals while employers in other areas have much less access to the new graduates. The practice of widespread campus recruiting on the part of major industrial concerns, so common in the case of engineering and science graduates, does not appear to have developed to a comparable extent with respect to technicians. Whereas the engineering labor market is nationwide and highly mobile, the market for technicians is largely local or regional, with many close ties between individual schools and nearby industries.

Recruiting Experience of Employers

Allowing for the subjective nature of this question as previously pointed out, employers generally reported greater difficulty in hiring technicians in 1968 than they had encountered in 1967. Experienced technicians were noticeably the most difficult to find, the trainees the least, as indicated in Table 20. The difficulty in locating experienced technicians was apparently greater than for engineers at all degree levels (see Table 10).

The pattern for different types of employers was less variable than for engineers and there were no industries that indicated a significant lessening of recruiting difficulty. The demand for new graduates was softest in aerospace, machinery, petroleum, and the federal government. Experienced technicians were apparently also quite easy to hire in the federal government and the petroleum industry, but not in aerospace or machinery. Trainees appeared to be in fairly plentiful supply. Appendix Table 5 on page 32 shows the complete breakdown by employment area.

Need for New Technical Institute Programs

Twenty three percent of the respondents indicated that there was a need for new institutions or programs in some field of interest to them. Because of the great variety of suggestions received, these will be the subject of a separate analysis.

TABLE 20

EMPLOYER'S SUBJECTIVE EVALUATION OF DIFFICULTY IN HIRING TECHNICIANS 1968 COMPARED WITH 1967

	NO. OF REPLIES	% MORE DIFFICULT	% SAME	% LESS DIFFICULT
New Tech. Inst. Graduates	486	31	62	7
Experienced Technicians	525	40	55	5
Trainees for Upgrading	481	23	71	6

APPENDIX TABLE 1

ENGINEERS AND TECHNICIANS IN RESPONDENT COMPANIES CLASSIFIED BY COMPANY SIZE AS MEASURED BY TOTAL EMPLOYEES

TOTAL EMPLOYED BY RESPONDENT	NUMBER OF RESPONDENTS	TOTAL ENGINEERS AND TECHNICIANS IN SURVEY SAMPLE
0–25	40	419
26–100	105	2,909
101–500	326	15,242
501–1,500	165	22,298
1,501–5,000	169	56,009
5,001–15,000	55	36,678
15,001–30,000	14	38,601
30,001–50,000	7	17,653
MORE THAN 50,000	11	76,310
NOT REPORTED	34	4,498
ALL RESPONDENTS	926	270,617

APPENDIX TABLE 2

ENGINEERS AND TECHNICIANS IN RESPONDENT COMPANIES CLASSIFIED BY COMPANY SIZE AS MEASURED BY EMPLOYMENT OF ENGINEERS & TECHNICIANS

ENGINEERS AND TECHNICIANS EMPLOYED BY RESPONDENT	NUMBER OF RESPONDENTS	TOTAL ENGINEERS AND TECHNICIANS IN SURVEY SAMPLE
0–10	184	975
11–25	174	2,993
26–50	114	4,146
51–100	142	10,342
101–200	112	16,147
201–500	92	29,000
501–1,000	52	37,578
MORE THAN 1,000	46	169,436
NOT REPORTED	10	0
ALL RESPONDENTS	926	270,617

APPENDIX TABLE 3

ESTIMATED NUMBER OF ENGINEERS TO BE HIRED FOR VARIOUS CURRICULA

			CURRICULUM								
INDUSTRY	RETURNS	EST. HIRES	AERO-SPACE	CHEM-ICAL	CIVIL	ELEC-TRICAL	INDUS-TRIAL	MECH-ANICAL	METAL-LURGICAL	OTHER	NO SPECIFIC CURRICULUM
AEROSPACE	20	4,757	908	35	507	1,649	71	1,432	39	15	101
CHEMICAL	22	1,798	0	884	86	136	115	461	49	67	0
CONSTRUCTION	37	830	0	84	292	118	22	229	13	34	38
CONSULTING	56	1,086	0	64	597	149	33	173	4	52	14
ELECTRICAL & ELECTRONICS	63	2,592	31	51	45	1,465	206	441	29	133	191
MACHINERY	56	1,114	8	37	12	128	107	711	46	42	23
METALS	63	699	13	49	65	80	87	223	122	23	37
OTHER MFG.	82	1,428	60	254	40	362	110	516	27	42	17
PETROLEUM	23	975	0	297	122	108	52	220	146	15	15
R & D	19	991	7	82	18	520	10	162	35	155	2
TRANSPORTATION	12	79	10	1	29	13	12	12	1	0	1
UTILITIES	68	1,034	0	21	92	555	26	258	16	50	16
FED. GOV'T.	14	909	83	17	64	421	29	167	27	82	19
STATE GOV'T	23	1,304	0	3	1,188	26	2	25	54	6	0
LOCAL GOV'T.	29	329	0	8	266	26	1	15	1	2	10
EDUCATION	111	992	69	89	164	228	65	212	34	74	57
ALL RESPONDENTS	698	20,917	1,189	1,976	3,587	5,984	948	5,257	643	792	541

APPENDIX TABLE 4

1968 ENGINEER RECRUITMENT COMPARED TO 1967

			HOW RESPONDENTS REPORTED DEGREE OF DIFFICULTY IN RECRUITING ENGINEERS (%)													
			NEW GRAD.BACH.			NEW GRAD.MSTRS.			NEW GRAD.DRS.			EXP.GRAD.ENG.			NON-GRAD.		
INDUSTRY	NO. OF RESPOND.	NO.OF HIRES	MORE	SAME	LESS	MORE	SAME	LESS	MORE	SAME	LESS	MORE	SAME	LESS	MORE	SAME	LESS
AEROSPACE	23	6,374	15	50	35	19	50	31	17	58	25	29	43	29	19	48	33
CHEMICAL	39	1,414	24	38	11	30	65	4	19	81	0	22	63	15	6	70	24
CONSTRUCTION	53	847	38	54	8	22	74	4	19	81	0	46	46	8	37	60	3
CONSULTING	68	1,073	44	48	8	42	46	12	38	56	5	42	50	8	35	56	10
ELECTRICAL & ELECTRONICS	86	3,812	28	59	10	29	61	10	32	53	15	29	58	13	15	63	22
MACHINERY	77	1,016	36	58	7	30	60	10	28	64	8	30	58	12	24	65	11
METALS	88	579	46	52	2	39	61	0	38	58	4	44	50	6	25	61	14
OTHER MFG.	123	1,429	34	60	1	54	44	2	60	35	5	48	44	8	33	48	20
PETROLEUM	27	747	20	70	10	21	71	7	25	67	8	20	75	51	22	78	0
R & D	25	936	33	52	14	28	56	17	23	59	18	24	57	19	9	73	18
TRANSPORTATION	16	61	64	27	9	43	43	14	40	60	0	58	33	8	29	71	0
UTILITIES	83	822	40	50	11	29	71	0	23	77	0	33	50	17	27	67	7
FED. GOV'T	15	987	7	47	47	7	86	7	31	62	8	0	64	36	0	78	22
STATE GOV'T	26	1,340	62	35	4	50	50	0	56	44	0	41	59	0	22	56	22
LOCAL GOV'T	42	471	68	29	3	59	41	0	46	54	0	53	43	3	25	71	4
EDUCATION	135	1,360	34	62	4	27	67	6	30	52	18	27	60	13	21	63	16
ALL RESPONDENTS	926	23,268	38	53	9	34	60	7	33	57	10	36	53	11	24	61	15

Note: Percentages based on number of employers answering each part separately. (Percentages may not add to 100 due to rounding.)

APPENDIX TABLE 5

1968 TECHNICIAN RECRUITMENT COMPARED TO 1967

			HOW RESPONDENTS REPORTED DEGREE OF DIFFICULTY IN RECRUITING TECHNICIANS (%)								
			NEW TECH.INST.GRAD.			EXPERIENCED TECHS.			TRAINEES FOR UPGRADE		
INDUSTRY	NO. OF RESPOND.	NO. OF HIRES	MORE	SAME	LESS	MORE	SAME	LESS	MORE	SAME	LESS
AEROSPACE	23	2,251	23	62	15	60	33	7	17	75	8
CHEMICAL	39	340	36	64	0	35	61	4	33	62	5
CONSTRUCTION	53	238	27	68	5	45	45	9	32	58	11
CONSULTING	68	966	41	49	9	40	51	9	22	69	10
ELECTRICAL & ELECTRONICS	86	3,060	30	61	8	28	64	8	24	65	11
MACHINERY	77	583	24	61	15	46	46	8	24	68	8
METALS	88	692	27	65	8	52	48	0	22	71	6
OTHER MFG.	123	1,102	32	64	4	47	50	3	27	69	4
PETROLEUM	27	570	18	82	0	9	91	0	17	83	0
R & D	25	786	38	62	0	43	57	0	6	88	6
TRANSPORTATION	16	72	50	50	0	33	67	0	33	67	0
UTILITIES	83	1,121	34	62	4	33	62	4	23	75	2
FED. GOV'T	15	261	20	80	0	0	100	0	0	100	0
STATE GOV'T	26	3,686	40	50	10	43	52	5	19	76	5
LOCAL GOV'T	42	356	29	71	0	48	48	4	20	80	0
EDUCATION	135	252	26	68	6	35	59	6	20	76	4
ALL RESPONDENTS	926	16,336	31	62	7	40	55	5	23	71	6

PLEASE DO NOT WRITE IN THESE SPACES

DEMAND FOR ENGINEERS

In Industry, Education, and Government

A survey conducted by
Engineering Manpower Commission
of Engineers Joint Council
in cooperation with the
National Industrial Conference Board

Please complete and return this form to:

ENGINEERING MANPOWER COMMISSION
345 East 47th Street
New York, New York 10017

. . . as promptly as possible, but not later than July 31, 1968.

Reporting Organization: NAME _____

STREET ADDRESS _____

CITY _____

STATE _____ ZIP CODE _____

Please indicate whether report is for:

Above location only _____ Headquarters plus subsidiaries _____

Other (specify) _____

Name and Title of person responsible for data _____

Product or service. (Please give 4-digit S.I.C. code if possible, otherwise select the one most appropriate category from preferred list on the back of this sheet.) _____

Approximate number of employees in reporting organization. _____

In what month does your organization usually firm up its recruiting goals? _____

Please report as accurately as possible. Where exact numbers are not available, use your most reliable estimates. Note that statistics are being requested for the school year (July through June) rather than for the calendar year. If you cannot provide data for this period, please give information for the closest 12-month period available and indicate the period covered:

_____

Only statistical summary data will be published, and replies of individual participants will not be disclosed in any way. A complimentary copy of the report will be mailed to participants.

QUESTIONNAIRE CONFIDENTIAL WHEN FILLED OUT

SURVEY CATEGORIES USUALLY REPORTED BY EMC

Manufacturing
- Aerospace
- Business machines
- Ceramic products, stone, clay, glass, cement
- Chemicals, drugs, plastics, rubber
- Electrical machinery & equipment
- Electronic equipment (other than household)
- Food and consumer products
- Household appliances (include radio, TV)
- Instruments (precision)
- Lumber & wood products
- Machinery (other than electrical)
- Metal products, fabricated
- Metals, basic
- Paper products
- Petroleum
- Transportation equipment
- Other (Please specify only if none of the above caterogies is satisfactory)

Non-Manufacturing
- Agriculture, forestry, fisheries
- Business, trade, publishing
- Communication services
- Construction
- Consulting & engineering services
- Mining
- Research organizations & laboratories
- Transportation services
- Utilities

Government
- Federal
- State
- Local

Educational Institutions
- Colleges & Universities
- Technical institutes & junior colleges
- Other schools
- Professional societies & non-profit institutions

PLEASE DO NOT WRITE IN THESE SPACES

DEMAND FOR ENGINEERS

I. Number of engineers in your employ as of July 1 of the year indicated:

		1967	1968
A. Engineering Graduates (employed in all activities including supervision and management.)	1		
B. Non-graduate engineers*	2		
Total (1 + 2)	3		

II. Separations of personnel in I above during the 12-month period indicated:

		ACTUAL July '67—June '68	EST. July '68—June '69
A. Deaths	4		
B. Retirements	5		
C. Resignations	6		
D. Discharges	7		
E. Layoffs (not offset by reinstatements)	8		
F. Armed Forces (excess of departures over returns)	9		
G. Other (Specify)	10		
Total 4 + 5 + 6 + 7 + 8 + 9 + 10)	11		

III. Employment additions planned and achieved during the 12-month period indicated:

			HIRING GOAL July '67—June '68	ACTUAL HIRES July '67—June '68	PLANNED HIRES July '68—June '69
A. New engineering graduates hired direct from school	Bachelor	12			
	Master	13			
	Doctor	14			
Total new engineering graduates (12 + 13 + 14)		15			
B. Experienced graduate engineers		16			
Total graduate engineers (15 + 16)		17			
C. Non-graduate engineers* from all sources		18			
Total engineering additions (17 + 18)		19			

IV. Net accessions (19 minus 11): 20

*Non-graduate engineers are defined as men lacking an engineering degree, but whose experience and training permit them to hold positions normally requiring such a degree.

V. Current availability of engineers:
Based on your knowledge of current recruiting operations, please indicate the experience of your organization. Check one box on each line.

		MORE DIFFICULT	ABOUT THE SAME	LESS DIFFICULT
A. The recruitment of new engineering graduates (bachelor) is — compared to this time last year.	21	☐	☐	☐
B. The recruitment of new graduate engineers (master) is — compared to this time last year.	22	☐	☐	☐
C. The recruitment of new graduate engineers (doctor) is — compared to this time last year.	23	☐	☐	☐
D. The recruitment of experienced engineering graduates is — compared to this time last year.	24	☐	☐	☐
E. The recruitment of non-graduate engineers* is — compared to this time last year.	25	☐	☐	☐

VI. Please indicate major curriculum groupings for engineers currently employed, and the numbers you would prefer for those planned to be hired between July 1968 and June 1969:

		EMPLOYED AS OF July 1, 1968	PLANNED HIRES July '68—June '69
Aerospace and related	26		
Chemical and related	27		
Civil and related	28		
Electrical, electronics & related	29		
Industrial and related	30		
Mechanical and related	31		
Metallurgical, mining, petroleum, etc.	32		
Other curricula (specify)	33		
No specific curriculum required, but engineering degree needed.	34		
Total (Current employment should equal line 1 for 1968; planned hires should equal line 19 for 1968-9.)	35		

VII. Please indicate the general functional area for engineers currently employed, and the numbers planned to be hired between July 1968 and June 1969:

		EMPLOYED AS OF July 1, 1968	PLANNED HIRES July '68—June '69
Installation, maintenance, etc.	36		
Production, construction, operation, etc.	37		
Design and related activities	38		
Research and related activities	39		
Sales and related activities	40		
Quality control and related activities	41		
Management, including trainees	42		
Other (specify if desired)	43		
Total (should equal line 35 above)	44		

*Non-graduate engineers are defined as men lacking an engineering degree, but whose experience and training permit them to hold positions normally requiring such a degree.

PLEASE DO NOT WRITE IN THESE SPACES

DEMAND FOR TECHNICIANS

in Industry, Education, and Government

A survey conducted by
Engineering Manpower Commission
of Engineers Joint Council
in cooperation with the
National Industrial Conference Board

Please complete and return this form to:

ENGINEERING MANPOWER COMMISSION
345 East 47th Street
New York, New York 10017

. . . as promptly as possible, but not later than July 31, 1968.

Reporting Organization: NAME _____

STREET ADDRESS _____

CITY _____

STATE _____ ZIP CODE _____

Please indicate whether report is for:

Above location only _____ Headquarters plus subsidiaries _____

Other (specify) _____

Name and Title of person responsible for data _____

Product or service. (Please give 4-digit S.I.C. code if possible, otherwise select the one most appropriate category from preferred list on the back of this sheet.) _____

Approximate number of employees in reporting organization. _____

In what month does your organization usually firm up its recruiting goals? _____

Please report as accurately as possible. Where exact numbers are not available, use your most reliable estimates. Note that statistics are being requested for the school year (July through June) rather than for the calendar year. If you cannot provide data for this period, please give information for the closest 12-month period available and indicate the period covered:

_____

Only statistical summary data will be published, and replies of individual participants will not be disclosed in any way. A complimentary copy of the report will be mailed to participants.

QUESTIONNAIRE CONFIDENTIAL WHEN FILLED OUT

SURVEY CATEGORIES USUALLY REPORTED BY EMC

Manufacturing

- Aerospace
- Business machines
- Ceramic products, stone, clay, glass, cement
- Chemicals, drugs, plastics, rubber
- Electrical machinery & equipment
- Electronic equipment (other than household)
- Food and consumer products
- Household appliances (include radio, TV)
- Instruments (precision)
- Lumber & wood products
- Machinery (other than electrical)
- Metal products, fabricated
- Metals, basic
- Paper products
- Petroleum
- Transportation equipment
- Other (Please specify only if none of the above caterogies is satisfactory)

Non-Manufacturing

- Agriculture, forestry, fisheries
- Business, trade, publishing
- Communication services
- Construction
- Consulting & engineering services
- Mining
- Research organizations & laboratories
- Transportation services
- Utilities

Government

- Federal
- State
- Local

Educational Institutions

- Colleges & Universities
- Technical institutes & junior colleges
- Other schools
- Professional societies & non-profit institutions

V. Technician trainee hires planned and achieved:

		HIRING GOAL July '67–June '68	ACTUAL HIRES July '67–June '68	PLANNED HIRES July '68–June '69
A. High school vocational graduates	17			
B. Other high school graduates hired as technician trainees	18			
Total technician trainee additions (17 + 18)	19			

VI. Based on your knowledge of current recruiting operations, please indicate the experience of your organization. Check one box on each line.

		MORE DIFFICULT	ABOUT THE SAME	LESS DIFFICULT
A. The recruitment of new graduates of technical institutes is — compared to this time last year.	20			
B. The recruitment of experienced technicians is — compared to this time last year.	21			
C. The recruitment of trainees capable of being upgraded to technician status is — compared to this time last year.	22			

VII. Please indicate major curriculum groupings for technicians currently employed, and the numbers you would prefer for those planned to be hired between July 1968 and June 1969:

		EMPLOYED AS OF July 1, 1968	PLANNED HIRES July '68–June '69
Chemical and related	23		
Civil engineering & related	24		
Drafting, design, and related	25		
Electrical, electronics & related	26		
Industrial and related	27		
Mathematical, computer, and related	28		
Mechanical and related	29		
Physical sciences	30		
Other (Specify)	31		
Total (Current employment should equal line 1 for 1968; planned hires should equal line 15 for 1968-9.)	32		

VIII. Please indicate the general functional area for technicians currently employed, and the numbers planned to be hired between July 1968 and June 1969:

		EMPLOYED AS OF July 1, 1968	PLANNED HIRES July '68–June '69
Installation, maintenance, etc.	33		
Production, construction, operation, etc.	34		
Design and related activities	35		
Research and related activities	36		
Sales and related activities	37		
Quality control and related activities	38		
Other (Specify)	39		
Total (Should equal line 32 above)	40		

IX. In your opinion, should the technical institutes and similar post-high school training centers offer new curriculum areas:

41 Yes ☐ No ☐ If yes, please specify. 42 _____

X. Please list technical institutions at which you actively recruited in 1967-68. (Use additional sheet if necessary.)

_____

_____

V. Technician trainee hires planned and achieved:

		HIRING GOAL July '67–June '68	ACTUAL HIRES July '67–June '68	PLANNED HIRES July '68–June '69
A. High school vocational graduates	17			
B. Other high school graduates hired as technician trainees	18			
Total technician trainee additions (17 + 18)	19			

VI. Based on your knowledge of current recruiting operations, please indicate the experience of your organization. Check one box on each line.

		MORE DIFFICULT	ABOUT THE SAME	LESS DIFFICULT
A. The recruitment of new graduates of technical institutes is — compared to this time last year.	20			
B. The recruitment of experienced technicians is — compared to this time last year.	21			
C. The recruitment of trainees capable of being upgraded to technician status is — compared to this time last year.	22			

VII. Please indicate major curriculum groupings for technicians currently employed, and the numbers you would prefer for those planned to be hired between July 1968 and June 1969:

		EMPLOYED AS OF July 1, 1968	PLANNED HIRES July '68–June '69
Chemical and related	23		
Civil engineering & related	24		
Drafting, design, and related	25		
Electrical, electronics & related	26		
Industrial and related	27		
Mathematical, computer, and related	28		
Mechanical and related	29		
Physical sciences	30		
Other (Specify)	31		
Total (Current employment should equal line 1 for 1968; planned hires should equal line 15 for 1968-9.)	32		

VIII. Please indicate the general functional area for technicians currently employed, and the numbers planned to be hired between July 1968 and June 1969:

		EMPLOYED AS OF July 1, 1968	PLANNED HIRES July '68–June '69
Installation, maintenance, etc.	33		
Production, construction, operation, etc.	34		
Design and related activities	35		
Research and related activities	36		
Sales and related activities	37		
Quality control and related activities	38		
Other (Specify)	39		
Total (Should equal line 32 above)	40		

IX. In your opinion, should the technical institutes and similar post-high school training centers offer new curriculum areas:

41 Yes ☐ No ☐ If yes, please specify. 42 _____

X. Please list technical institutions at which you actively recruited in 1967-68. (Use additional sheet if necessary.)

_____

_____

ENGINEERS JOINT COUNCIL MEMBERSHIP

MEMBER SOCIETIES

American Society of Civil Engineers
American Institute of Mining, Metallurgical and Petroleum Engineers
American Society of Mechanical Engineers
American Society for Engineering Education
Society of Naval Architects and Marine Engineers
American Society for Testing and Materials
American Society of Agricultural Engineers
American Institute of Consulting Engineers
American Society for Metals
Society for Experimental Stress Analysis
Instrument Society of America
American Institute of Industrial Engineers
Society of Fire Protection Engineers
American Institute of Plant Engineers
American Association of Cost Engineers

ASSOCIATE SOCIETIES

American Water Works Association
American Concrete Institute
Air Pollution Control Association
Society of American Military Engineers
Water Pollution Control Federation
National Institute of Ceramic Engineers
American Society for Non-Destructive Testing
Society of Packaging and Handling Engineers
American Society for Quality Control
International Material Management Society
Society of Women Engineers
Society for the History of Technology
Fluid Power Society
Western Society of Engineers
Michigan Engineering Society
Louisiana Engineering Society
North Carolina Society of Engineers
Washington Society of Engineers
Engineering Societies of New England
South Carolina Society of Engineers
Los Angeles Council of Engineers and Scientists
Hartford Engineers Club
International Materials Management Society (New Jersey Chapter)
Chinese Institute of Engineers (New York)